PART II
WATER RESOURCE MANAGEMENT, STRATEGIES AND RECOMMENDATIONS

10.0 OVERVIEW

10.1 RELATION TO MANAGEMENT FRAMEWORK

The following chapters present and discuss resource options and strategies that were considered in developing the WUDP and addressed in the public process, which commenced in 2004. Proposed strategies are broadly defined as any measure, program, policy or improvement that 1. Address identified issues and concerns, 2. Meet one or several established planning objectives and 3. Reflect the values and guiding principles distilled during the community outreach process. Following the Statewide Framework for preparing the WUDP, the planning objectives form the basis of the alternative resource strategies in this section. Planning objectives derived through the public process were compared to the goals, objectives and policies established in the General Plan, Maui Island Plan and Community Plans to ensure consistency and identify any conflicts.

The tenets that guide development of the strategies and that should continue to permeate implementation of this plan can be summarized as follows:

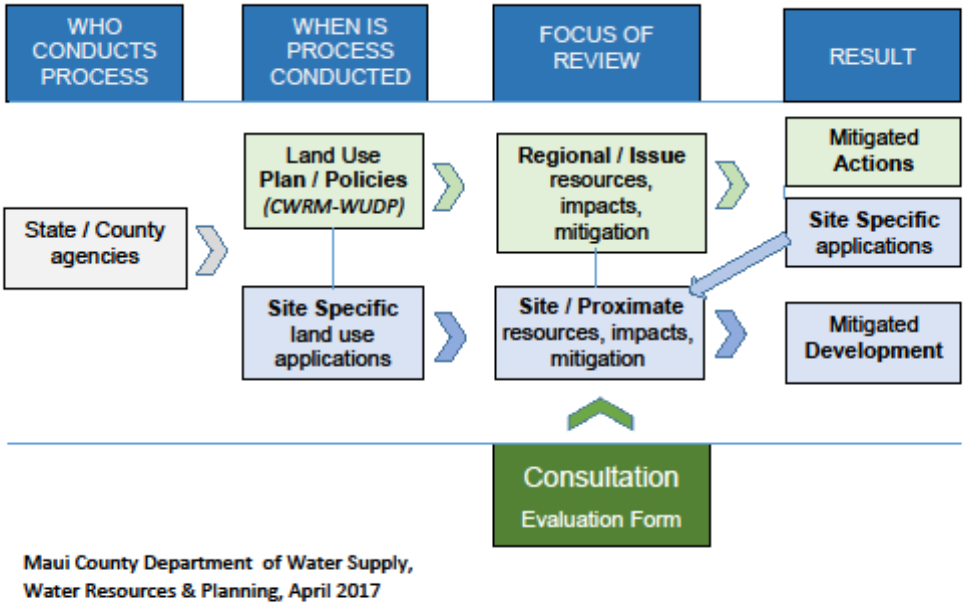
- Ecologically holistic and sustainable
- Based on ahupua'a management principles
- Legal, science and community-based
- Action-oriented

10.2 KA PA`AKAI ANALYSIS

In order to identify and protect native Hawaiian cultural, historical and natural resources and help ensure native Hawaiian customary and traditional rights, a *Ka Pa'akai* analysis and consultation process has been conducted as directed by the Hawai`i Supreme Court ruling in *Ka Pa'akai O Ka `Aina v. Land Use Commission* (2000), which provided an analytical framework "to effectuate the State's obligation to protect native Hawaiian customary and traditional practices while reasonably accommodating competing private [property] interests."[1] While a Ka Pa`akai analysis is generally performed for a site specific development project, it should also be applied at the planning stage if there are policies or strategies that may affect traditional and customary rights (e.g. water transfers) or if there are location-specific development proposals (e.g. new well construction, diversions, desalination, etc).

[1] 94 Hawai`i 31, 7 P3d 1087 (2000)

Figure 10-1 Ka Pa`akai Analysis Process Simplified



Preliminary Research

The following sources were consulted in order to gather pertinent native Hawaiian information, catalog traditional and cultural resources, evaluate the impacts of the WUDP and protect native Hawaiian traditional and customary rights.

Community Meetings and Survey Data Capture: Native Hawaiian comments fielded in WUDP community meetings and surveys, and consultations were recorded or collected, taken into consideration during the WUDP process, and provided online as part of the public record.

OHA Native Hawaiian Databases: Kipuka and Papakilo databases developed by the Office of Hawaiian Affairs were consulted in order to gather pertinent native Hawaiian information for use in the WUDP, identify traditional and cultural resources, anticipate impacts and protect native Hawaiian rights.

State Inventory of Historic Places. The consultation notice was sent to the State Historic Preservation Division of DNLR, which maintains the official list of all known cultural and historic properties that have been discovered or recorded through survey work.

Environmental Impact Statements and Environmental Assessments: The list of EIS's and EA's for Maui maintained by the State Office of Environmental Quality Control was reviewed for information relevant to the Ka Pa`akai analysis, focusing on plan level documents as well as topical or locational documents of particular relevance (http://www.health.hawaii.gov/oeqc/).

Kuleana/Appurtenant Water Use: Another method used to identify traditional and cultural resources and anticipate impacts was to evaluate the GIS-based Office of Hawaiian Affairs (OHA) kuleana parcel data, along with the 1989 Declarations of Water Use, Hawaii Stream Assessment, agricultural land use data, pre-contact settlement patterns, East Maui Streams and Na Wai `Eha Contested Case documents, and other data to assess present and potential future kuleana water needs.

Land Commission Awards (LCAs): The presence of LCAs is one indicator of native Hawaiian activities or presence in the mid-to-later half of the nineteenth century.

Na Wai `Eha Contested Case documents, and other data to assess present and potential future kuleana water needs.

Sources: A list of sources consulted as a means of identifying resources, impacts and mitigations are provided in Appendix 9a.

Consultation

An initial consultation list was developed consisting of culturally-relevant individuals, organizations, and government agencies. The Native Hawaiian Organization Notification List, U.S. Department of the Interior, maintained and updated by the Office of Native Hawaiian Relations at https://www.doi.gov/hawaiian/NHOL was also consulted. A consultation packet was distributed to the various culturally-related entities: (1) explaining the process and project; (2) providing a matrix preliminarily analyzing resources, impacts and mitigations associated with preliminary strategies; and (3) providing an Evaluation Form for respondent use if desired requested information for the analysis; and (4) requesting names of any persons MDWS is advised to contact, and persons the respondent reached out to.

The Aha Moku o Maui Advisory Committee was contacted as an organization, its regional members were contacted, and Aha Moku O Maui was contacted as well. A meeting with Maui Aha Moku Advisory Committee was arranged in early 2017. A desired outcome of outreach to the Aha Moku committees was establishing a consultation procedure and to reach out to cultural practitioners. Input was also solicited from the Maui County Historic and Cultural Resources Commission.

Obtaining information on the significant native Hawaiian traditional and customary rights areas may be difficult because: 1) practitioners may not be willing to share information about their practices because some of these practices are closely held family “secrets”; 2) the proposed strategies and actions in the WUDP are general in nature and not location specific; and 3) the practitioners are unlikely to know the impacts of these strategies on their specific

practices. However, in order to mitigate these challenges, the outreach process included the following considerations:[2]

1. The consultation process was designed to place the burden of reaching out to practitioners and vetting native Hawaiian traditional and customary rights issues and impacts on the County as the preparer of the WUDP. The consultation packet identified organizations contacted, and asked respondents to identify persons the County should contact.

2. Review of the federal Native Hawaiian Organizations' Notification List as a means to contact practitioners.

3. Provision of a matrix of preliminary analysis of potential resources, impacts and mitigations to a wide and diverse group of organizations as a starting point to assist in understanding the potential actions and to assist the process of addressing native Hawaiian traditional and customary rights issues.

4. The County`s outreach included a request for comments, including review of the process and project and consultation packet at a public meeting of County's Historical and Cultural Resources Commission public meetings, which elicited public comment along with Commissioner comments.

Consultation with Maui Aha Moku Advisory Committee

In order to identify traditional and cultural resources, anticipate impacts, and protect native Hawaiian rights, MDWS consulted the Maui Aha Moku Advisory Committee, which possesses knowledge of persons who may be consulted on these issues. The Maui Island Aha Moku (Moku O Pi``ilani) was also consulted and has been actively engaged in the WUDP process. In addition to the official representatives, Maui Aha Moku Advisory Committee and Aha Moku O Maui members were directly contacted.

The role of the Aha Moku Advisory Committee (AMAC) is to proactively advise the State of Hawai`i Department of Land and Natural Resources (DLNR) and its divisions, as well as collaborate with state, county, and federal agencies, and the state legislature on how to affirmatively protect and preserve Native Hawaiian rights, traditional and customary practices, and natural and cultural resources that are protected as part of the public trust.

The Committee, in its advisory role, reaffirms and shall protect all Native Hawaiian rights, customarily and traditionally exercised for subsistence, cultural and religious purposes. During meetings with the Water Committee of Moku O Pi`ilani and members of Wailuku, Kula, Honua`ula and other mokus, strong support was voiced for initiating and implementing a native

[2] Adapted from Fukanaga & Associates, Inc., Hawaii County Water Use an Development Plan Update, Keahou Aquifer System, Phase 2 (Pre-Release Review Draft Report), August 2016, Chapter 2.

Hawaiian consultation process for the WUDP. The recently adopted *Rules of Practice and Procedure* for the AMAC defines "Collaborative governance" as a "governing arrangement wherein one or more public agencies such as the DLNR and its divisions, directly engage non-State stakeholders, such as the AMAC and island `aha moku councils, in a collective decision-making process that is *formal*, *consensus-oriented*, and *deliberative* and that aims to make or implement public policy or manage public programs or assets. Collaboration implies two-way communication and influence between agencies and stakeholders. Although ultimate authority lies with the department, stakeholders directly participate in the decision-making process". The rules also sets forth the communication process in advising agencies for those participating in the `aha moku system as well as a form for the island Po`o (representative) to use.

Community Outreach

In order to consult with a balanced and diverse expertise base within Maui`s native Hawaiian community, the following organizations were contacted requesting their participation in order to gather the Ka Pa`akai analysis information used to catalog traditional and cultural resources, anticipate impacts and protect native Hawaiian rights. The Native Hawaiian Organization Notification List, U.S. Department of the Interior, maintained and updated by the Office of Native Hawaiian Relations at https://www.doi.gov/hawaiian/NHOL was also consulted.

1. Department of Hawaiian Homelands (DHHL)
2. Office of Hawaiian Affairs (OHA)
3. State of Hawai`i Office of Historic Preservation
4. County of Maui Planning Department
5. County of Maui Historical and Cultural Resources Commission
6. State of Hawai`i Office of Planning
7. State of Hawai`i Commission on Water Resource Management
8. State of Hawai`i Historic Preservation Division
9. Native Hawaiian Legal Corporation
10. Maui Hawaiian Civic Clubs
11. Maui Aha Moku Advisory Committee
12. Aha Moku O Maui
13. Native Hawaiian Organizations Association
14. Earth Justice
15. Hui o Na Wai `Eha
16. Coalition to Protect East Maui Water Resources
17. Maui Tomorrow
18. Kamehameha Schools
19. University of Maui Hawaiian Studies Department
20. University of Hawaii at Manoa Hawaiian Studies Department
21. Ka Huli Ao Center for Excellence in Native Hawaiian Law at the University of Hawaii`s William S. Richardson School of Law

22. University of Hawaii Environmental Center
23. Maui Aha Moku Advisory Committee
24. Ka Piko O Ka Na`auao, The Hawaiian Learning Center
    Luana Kawaÿa, Kumu Hula & Cultural Specialist
25. Halau Hula Malani O Kapehe
26. Halau Hula Kauluokala
27. Halau Kekuaokala`au`ala`iliahi
28. Halau Na Lei Kaumaka O Uka
29. Hula Alapa`i – Malu Ulu `O Lele
30. Halau Ke`alaokamaile

Ka Paʻakai Analysis

(1) Identification and scope of "valued cultural, historical, or natural resources" in the impacted area, including the extent to which traditional and customary native Hawaiian rights are exercised in the area.

Identification and Scope of Resources

Unfortunately, there is no "standard" source for planning documents, permit applicants or approving agencies to consult regarding valued cultural and historical or natural resources and potential native Hawaiian traditional and customary practices. Through application of the Ka Pa`akai framework, analysis can be accomplished by gathering enough decision-making information to generate an accurate contextual analysis. Based upon consultations with knowledgeable individuals and organizations (including native Hawaiian cultural organizations, and community leaders), *Kamaʻāina* expert testimony was sought-out to gather information for the WUDP. Through review of existing sources and studies, as well as *Kamaʻāina* experts, it appears that cultural practices within the context of the Maui Island WUDP include such broad categories as food, dance, physical practices, health, arts, flora, subsistence and religious practices and gathering places, cultural settings, and festivals and ceremonies.

The pre-contact native Hawaiian population centers and the ahupua`a land management system were focused on the island's streams and nearshore resources, and contemporary cultural, historical and natural resources and traditional and customary Native Hawaiian rights are similarly focused in those areas. The WUDP encompasses all of Maui Island, and while the residential and commercial land uses and users of water on Maui are clustered within the developed areas; residents, commercial ventures and agriculture exist throughout the island. Ground, surface and alternative water resources and their associated ecosystems, and wells, stream diversions, and other water development systems and conveyances that support existing and future development are located both near and far from the uses they serve. Thus, while pre-contact population centers and cultural practices were focused in certain areas such as streams and nearshore waters, present cultural practices may be affected by distant and

varied uses such as agriculture and population centers which transport water from culturally intensive and sensitive areas to those areas with less cultural usage intensity.

Community Meetings and Survey Data Capture

Responses to Consultation Notices: Two responses were received to the distribution of the consultation notice packet. 1) Kaniloa Kamaunu, Water Chair of Aha Moku O'Wailuku, and 2) The Hawai`i State Office of Planning.

OHA Native Hawaiian Databases: The Kipuka database was also examined but did not contain information concerning traditional and customary practices, groundwater uses or other public trust purposes, burials, traditional gathering places or information related to water use. The Kipuka database is not comprehensive and has not been updated since around 2005. This source should be consulted when a location specific implementation measure or activity is proposed. The Papakilo database consists of varied collections of data pertaining to historically and culturally significant places, events, and documents in Hawai`i`s history, including a historic sites database, Mahele awards, and place names.

State Inventory of Historic Places. The State Historic Preservation Division did not provide a response to the consultation notice. This is likely due to the general nature of the project and lack of identification of specific locations at which implementation activities may occur. This source should be consulted when a location specific implementation measure or project is proposed.

Environmental Impact Statements and Environmental Assessments: Environmental Assessments and Environmental Impact Statements filed since 1990, 20 of which were reviewed in greater detail, looking for content related to native Hawaiian traditional and customary practices and groundwater withdrawal. Most of the cultural issues that were discussed in these documents dealt with archaeological sites or paths through development sites, and only one report addressed the types of strategies proposed in the WUDP, particularly ground and surface water development on traditional and customary practices and habitat concerns.

Land Commission Awards: This source of information was not beneficial due to the general nature of the project and lack of specific locations at which activities may occur. This source should be consulted when a location specific implementation measure or activity is proposed.

(2) The extent to which those resources—including traditional and customary native Hawaiian rights—will be affected by the proposed actions; and (3) The feasible action, if any, to be taken to reasonably protect native Hawaiian rights if they are found to exist.

The WUDP provides the comprehensive framework for the development and use of water resources on Maui for all land uses and water users. Identification of the nature and scope of cultural, historic, and natural resources, including traditional and customary rights that may exist, provides the basis for the evaluation of the extent to which these resources may be affected or impaired by the policies, strategies and actions proposed in the WUDP. Some methods and resources used in the identification of resources and practices will also be utilized to identify impacts and potential mitigations upon native Hawaiian rights. While the WUDP policies, strategies and actions are typically not location specific, the WUDP provides the opportunity to holistically identify, evaluate and mitigate potential impacts at the earliest time possible. It also provides the opportunity to comprehensively address regional or island wide issues, such as watershed, groundwater or streamflow protection, that cannot be effectively addressed at the location specific project level. Therefore, conducting a thorough consultation and review process at this time is important.

WUDP Impacts and Mitigation

Preliminary strategies for the development and use of water resources on Maui have been identified through an assessment of water resources and needs over the next 20 years and community outreach has been incorporated as a tool to identify some of the strategies. A Matrix was prepared briefly assessing and summarizing how each preliminary strategy or measure may relate to protection of valued resources including traditional and customary native Hawaiian rights, including mitigation measures considered for inclusion in the WUDP to reduce those impacts. The Matrix is attached as Appendix 10.

Future Implementation of WUDP and Ka Pa`akai Analysis

The future implementation of the policies, strategies and actions set forth in the WUDP will generally occur through a wide variety of activities over the 20-year planning period, including capital improvement plans, regulatory changes, development of water sources including alternative resources and water system infrastructure, watershed management and conservation activities, among others. Agencies responsible for protecting traditional and customary native Hawaiian rights must conduct detailed inquiries into the impacts on those rights to ensure that proposed uses of land and water resources are pursued in a culturally appropriate way. While the WUDP process provides an opportunity to perform a high-level Ka Pa`akai analysis and integrate mitigation into the WUDP, or suggest mitigation to be applied at the implementation or development permit stage; some implementation measures or projects may require a future Ka Pa`akai analysis prior to being carried out. The table below attempts to broadly characterize the types of implementation that may be subject to a future Ka Pa`akai analysis, with the caveat that the table is strictly for informational purposes only and is not to be relied upon in determining whether to conduct a Pa Ka`akai analysis.

The CWRM staff advised the County of the need to include the Ka Pa`akai process as part of the development of the WUDP, and the CWRM staff is evaluating how to integrate the Ka Pa`akai process into its decision-making processes. These points of analysis could be added to CWRM applications for the applicant to address and for staff to vet. CWRM staff has identified the `Aha Moku Advisory Committee within the Department of Land and Natural Resources as a resource for examining traditional and customary rights. The `Aha Moku System includes several tiers from the individual Ahupua`a, which include traditional practitioners within an ahupua`a, to the statewide `Aha Moku Advisory Committee of traditional practitioners with one representative from each island. The potential role of the `Aha Moku in the CWRM process is under discussion.[3]

Table 10-1 Types of Implementation Activities Potentially Subject to Ka Pa`akai Analysis – Illustrative Only

Project Type	Action	Decision Making Agency
Groundwater development or monitoring	Ground water use permits, well permits, petition to designate ground water management area	CWRM
Surface water development or monitoring	Surface water use permits, stream channel alteration permits, stream diversion works permits, petitions to amend instream flow standards, petition to designate surface water management area	CWRM
Wastewater recycling, stormwater reuse, catchment, greywater, retention methods-	Discretionary development permits (subdivisions, large projects), capital improvement programs	Maui County Council, Planning Commission, County departments
Water systems- capital improvement programs	Discretionary development permits (subdivisions, large projects), capital improvement programs	Maui County Council, MDWS
Scientific, educational, technical investigations	Relevant permits for investigatory methods (monitoring wells, stream gages, etc.)	CWRM, County
Watershed management activities (fencing, species control, erosion control, etc.)	Funding decisions	County, DNLR
Regulatory changes	County or state code or rule changes	CWRM, County
Projects requiring an environmental impact report or environmental assessment	Various projects, projects in State Management Area	County, CWRM, DNLR

MDWS, WR&P, April 2017. This table is strictly for informational purposes only and is not to be relied upon in determining whether to conduct a Pa Ka`akai analysis.

[3] Adapted from Fukanaga & Associates, Inc., Hawaii County Water Use and Development Plan Update, Keahou Aquifer System, Phase 2 Pre-Release Review Draft Report, August 2016, Chapter 2.

Maui County Cultural Resources Commission Requested Additions

A May 10, 2017 letter from the Maui County Department of Planning's Cultural Resources Commission requested: 1) A comprehensive list of all kuleana water users should be developed and incorporated…consider consulting with Aha Moku o Maui to see if they have a list available; 2) Incorporate the three different definitions of kuleana water users (allodial, purchase, and registered); 3) provide definitions for terms used throughout the plan, such as "cultural practitioner," "Hawaiian" and "Native Hawaiian"; 4) incorporate information about the seven realms of ahupua`a-based land management; 5) differentiate between auwai and diversion ditch kuleana water users; and 6) provide information on the status of the evaluation forms that were sent out by the Department of Water Supply with the Ka Pa`akai Consultation request.

Aha Moku Definitions of "Realms"

Resource "realms" refer to the areas ancient 'aha councils considered when making decisions. One way the concepts of realms will be incorporated will be when discussing DWS strategies' possible impacts upon native Hawaiian cultural practitioner access and mitigation strategies. The "realms" will be considered when considering access mitigations for native Hawaiian cultural practitioners. However, due to time constraints and resource limitations, the "realms" paradigm may not be thoroughly integrated into the WUDP analysis: nevertheless, a summary explanation and definitions of the "realms" is incorporated as follows from the Final Rules of Practice and Procedure Department of Land and Natural Resources `Aha Moku Advisory Committee [Effective October 20, 2016]).

“Ka Lewalani” is a resource realm which encompasses everything above the land, the air, the sky, the clouds, the birds, the rainbows, etc.

“Kahakai Pepeiao” is a resource realm which begins where the high tide is to where the *lepo* (Dirt, earth, ground) starts. This is typically the splash zone where crab, limu, and ‘opihi may be located; sea cliffs; or a gentle shoreline dotted with a coastal strand of vegetation; sands where turtles and seabirds nest; extensive sand dune environs; and the like.

“Kanaka Hōnua” is a resource realm which includes the natural resources important to sustain people. However, care for these resources are based on their intrinsic value. Management is based on providing for the benefit of the resources themselves, rather than from the perspective of how these resources serve people.

“Ma Uka” is a resource realm which begins from the point where the lepo (soil) starts to the top of the mountain.

“Moana-Nui-Ākea” is a resource realm which is the farthest out to sea or along the ocean`s horizon one could perceive from atop the highest vantage point in one's area.

“Nā Muliwai” is a resource realm which comprises of all the sources of fresh water, ground or artesian water, rivers, streams, springs, including coastal springs that create brackish-water and contribute to healthy and productive estuarine environments.

“Wao Akua” means the sacred, montane cloud forest, core watershed, native plant community that is non-augmented and an area that was traditionally kapu (human access usually forbidden and prohibited).

“Wao Kele” is the saturated forest just below the clouds, the upland rainforest where human access is difficult and rare, and an area that is minimally augmented.

“Wao Nahele” is the remote forest that is highly inconvenient for human access; a primarily native plant community; minimally augmented; and utilized by early Hawaiians as a bird-catching zone.

“Wao Lāʻau” is a zone of maximized biodiversity comprised of a highly augmented lowland forest due to integrated agroforestry of food and fuel trees, hardwood trees, construction supplies, medicine and dyes, and lei-making materials.

“Wao Kānaka” is where the early Hawaiians chiefly settled. These were the kula lands, the sloping terrain between the forest and the shore that were highly valued and most accessible to the people. These were the areas where families constructed their hale, cultivated the land, conducted aquaculture, and engaged in recreation. For coastal ahupuaʻa, Wao Kānaka also extended into the sea to include fishponds and fisheries.

Commonly Used Terms Defined

"Hawaiian": Merriam-Webster's Dictionary defines "Hawaiian" as a native or resident of Hawai`i; *especially* one of Polynesian ancestry.

“Kamaʻāina expert testimony” means testimony from a Native Hawaiian person who is familiar from childhood with a particular locality. Testimony from kamaʻāina is recognized as the appropriate method to determine the nature of Hawaiian traditional and customary practices in general, and also specifically in describing the customs exercised in a given area. (50 H. 452, 440 P.2d 76).

"Native Hawaiian”: "Native Hawaiian" is a statutory term that refers to any individual whose ancestors were natives of the area which consists of the Hawaiian Islands prior to 1778.

"Native Hawaiian" versus "native Hawaiian": Whether the term "native Hawaiian" uses an upper case "N" or lower case "n" for "native" depends on the context. Use of an upper case "N" is a legal term that strictly refers to any individual whose ancestors were natives of the area which consists of the Hawaiian Islands prior to 1778; while lower-case "n" refers to others that may not be lineal descendants of the 1778 pre-European contact population: for example,

hanai (adopted) native Hawaiian cultural practitioners who are not related to a pre-1778 Hawaiian descendant, or practitioners who are not pre-1778 Hawaiian descendants, but who are part of a *hui* (cultural partnership, club, association, or organization). The PASH (Public Access Shoreline Hawai`i) court case leaves the door open for non-Native Hawaiians to participate in exercising native Hawaiian cultural practices as native Hawaiian practitioners, but it is likely that one would have to be part of a *hui, ohana*, or a non-Native Hawaiian *hanai* (adopted) member of a Hawaiian family.

"Native Hawaiian Cultural Practitioner": A native Hawaiian cultural practitioner is defined as one who practices native Hawaiian cultural traditions of the natives of the area which consists of the Hawaiian Islands prior to 1778. This definition focuses on cultural practices and does not necessarily require that the practitioner's ancestors were natives of the area which consists of the Hawaiian Islands prior to 1778

Kuleana Parcels

Although kuleana parcels do exist, their accurate quantification can be difficult. Kuleana rights generally refer to water used at the time land title was initially conveyed to and recorded by the title recipient (a process that began in 1845 and theoretically continued until 1895) may rightfully be used in connection with the same land in exactly the same way it was used at the time of title conveyance. Broader interpretations vary in their view of the types of titles and conveyances involved; the types of water uses protected; the types of lands protected; transportability of the water to other lands and uses; and transferability and extinction of the rights. Most of the water covered by these rights was used for wetland taro cultivation. During the period of the privatization of land in Hawai'i (1840--1855), kuleana, usually translated as "native tenant rights," constituted both a right to, and responsibility over, land for Hawaiians. Kuleana rights arose in the mid-1800s and protected the entitlement of Hawaiian tenant farmers and their descendants to, among other things, access landlocked real estate parcels ([*"Ua Koe Ke Kuleana O Na Kanaka" [Reserving The Rights Of Native Tenants: Integrating Kuleana Rights And Land Trust Priorities In Hawaii],* Harvard Law Review (2005*); Avoiding Trouble in Paradise,* Business Law Today *[December 2008]).*

The many varied definitions for "kuleana" water users include: 1) individuals who are descendants of those awarded land grants in the 1800s, but *are not* officially registered as having water rights with the State of Hawai`i, whose ancestors *were* natives of the area which consists of the Hawaiian Islands prior to 1778; 2) individuals who are descendants of those awarded land grants in the 1800s, but *are not* officially registered as having water rights with the State of Hawai`i, whose ancestors *were not* natives of the area which consists of the Hawaiian Islands prior to 1778; 3) individuals who are descendants of those awarded land grants in the 1800s, but *are* officially registered as having water rights with the State of Hawai`i, whose ancestors *were not* natives of the area which consists of the Hawaiian Islands prior to 1778; 4) individuals who are descendants of those awarded land grants in the 1800s, but *are* officially registered as having water rights with the State of Hawai`i, whose ancestors *were* natives of the area which consists of the Hawaiian Islands prior to 1778; 5) appurtenant rights holders who acquired their land and rights by way of land purchases after the Kuleana Act of

1850, granting allodial titles. The Kuleana Act of 1850, proposed by the King in Privy Council, passed by the Hawai'i legislature, created a system for private land ownership. (*Hawaii State Archives, DLNR, 2–4. Hoakalei Cultural Foundation. Retrieved 2017-01-28. The Kuleana Act remains the foundation of law pertaining to native tenant right).* Kalo cultivators who do not fall under the above definitions also exist, but they are not "*kuleana*" growers, and they do not have the same rights as *kuleana* growers.

From a legal perspective, "Kuleana" rights are appurtenant water rights to the use of water utilized by parcels of land at the time of their original conversion into fee simple lands i.e., when land allotted by the 1848 Mahele was confirmed to the awardee by the Land Commission and/or when the Royal Patent was issued based on such award, the conveyance of the parcel of land carried with it the appurtenant right to water.

Comprehensive List of all Kuleanas

A comprehensive list of all current kuleana users is very difficult to establish because the semantic variations of the definition include many users who are not officially registered with the State of Hawai`i; and families who hold Royal Patents do not necessarily identify with the State system. As appropriate, DWS could request the assistance of the Aha Moku o Maui in order to obtain a comprehensive list of all "kuleana" rights holders. Testimony submitted to the April 4, 2017 Maui Cultural Resources Commission meeting, suggested using the DLNR Aha Moku Maui Advisory Committee State of Hawai`i Aha Moku website to file a complaint with the Moku representative which would trigger the organization's procedures to have a list compiled.

10.3 WATER SUPPLY SUSTAINABILITY

Water Resource Sustainability is a foundation to the assessment and management of the island's water resources, as reflected in the plan's identified values and principles as well as the MIP goals, objectives and policies. Sustainable resources as a key planning objective relates to the use and management of groundwater, surface water as well as alternative water resources, to ensure its long term health both in terms of quantity and quality. Uncertainties that can affect a sustainable water supply include climate change, current and future land uses that may contaminate water resources, and threats to our native forests that make up our watersheds, such as invasive plant and animal species. Proactive efforts to manage and protect watersheds, streams and aquifers are a prerequisite for further use and development of the island's water resources and are therefore considered resource strategies to meet future demand. Ensuring sustainably used water resources also requires consideration and use of alternative sources of water, such as recycled water, brackish water and storm water where reasonable and practicable. Sustainable water use means applying conservation measures both for existing users and for new developments. Aggressive conservation practices can include efficient irrigation practices, ultra low flow water fixtures, on site use of storm water and grey water and other innovative but cost effective measures.

10.4 WATER QUALITY

Generally, ground and surface waters on Maui are of excellent quality. However, legacy pesticides from historic agricultural land uses are still detected in certain aquifers and require expensive treatment to ensure contaminants are within safe levels for drinking water supply. A wide range of activities associated with urban and agricultural land uses pose a risk of contaminating underlying groundwater. Contamination impacts on surface water sources can occur within minutes or hours, depending on the distance from the contamination incident to the distribution point. Of particular concern is runoff from flood conditions, ditch maintenance activities and possible eradication efforts in the watershed.[4]

The State Department of Health Safe Drinking Water Branch (SDWB) primary mission is to safeguard public health by protecting Hawaii's drinking water sources, including ground and surface waters, from contamination and assure that owners and operators of public water systems provide safe drinking water to the community. The Department administers the Underground Injection Control Program, The Groundwater Protection Program and the Drinking Water State Revolving Fund. The Federal Safe Drinking Water Act apply to all public water systems and sets requirements for drinking water standards, monitoring and reporting, treatment and enforcement.

11.0 WATER RESOURCE ADEQUACY

Comparing available resources to future demand and needs, long-term resource supply must be adequate to meet projected demand while maintaining watershed, stream and aquifer sustainability and replenishment. Resource adequacy means not just having enough water, but adequate quality of water for different types of needs, such as potable and irrigation uses.

11.1 CONVENTIONAL WATER SOURCE AVAILABILITY AND UNCERTAINTIES

Groundwater

Available groundwater is defined on a state level as sustainable yield and further restricted in groundwater management areas by water use permit limits. Except for the designated Iao groundwater management area, few aquifers on the island are developed to more than a fraction of sustainable yield. As discussed under Section 8, groundwater pumpage exceeding sustainable yield in Paia and Kahului aquifers of the Central Sector were a result of surface water import, both which significantly decreased with the cessation of sugarcane cultivation.

[4] 2014 Department of Health Water Quality Plan Draft

Table 11-1 Groundwater Yield and Pumpage

Aquifer Sector	Sustainable Yield	Pumpage (2014 Average)	% of Aquifer Pumped
Wailuku	36	20.761	58%
Lahaina	34	6.207	18%
Central	26	62.724	241%
Ko'olau	175	0.916	1%
Hāna	122	0.606	0%
Kahikinui	34	0	0%
Total	**427**	**91.214**	**21%**

Uncertainties related to groundwater resources include drought, climate change, water quality and water losses.

Drought and Climate Change

A hydrological drought refers to deficiencies in surface and subsurface water supplies, which are reflected in declining surface and ground water levels when precipitation is deficient over an extended period of time. Source water quality can be affected by sea water intrusion or upconing brackish water.[5] Estimates of groundwater recharge are used to evaluate the availability of freshwater and are used by CWRM in setting sustainable yield. Island wide, mean annual recharge is reduced by about 23 percent under drought conditions compared to average climate conditions, and is reduced about 19 to 37 percent by aquifer sector.[6] For all aquifer systems, the 2008 sustainable yield adopted by CWRM exceeds recharge under drought conditions; therefore sustainable yield can be used as the baseline for groundwater resources during drought conditions. Significant uncertainties remain in drought forecasting, both in terms of climate change and medium to long-term droughts. Climate change patterns already being seen in Hawai'i are projected to become increasingly serious before the middle of the 21st century, including (a) declining rainfall, (b) reduced stream flow, (c) increasing temperature, and (d) rising sea level. Each poses serious consequences for the replenishment and sustainability of groundwater and surface water resources. These trends are further compounded by potential changes in the trade wind regime, the intensity and frequency of drought and storm events, the El Nino-Southern Oscillation, and the Pacific Decadal Oscillation.[7] Sea level rise and the associated coastal impacts also have the potential to harm infrastructure and environments including low lying coastal roads, water supply and wastewater systems.[8] Water supply faces threats from both rising groundwater and saltwater

[5] WRPP, 2014, Drought Planning (Draft)

[6] Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai'i, 1978–2007

[7] Water Resources and Climate Change Adaptation in Hawai'i: Adaptive Tools in the Current Law and Policy Framework

[8] Maui County Countywide Policy Plan, p 14

intrusion in wells, as well as declining quality and quantity due to drought and downward trends in groundwater base flows.[9]

The Pacific Regional Integrated Sciences and Assessments' (Pacific RISA) *Maui Groundwater Project* is an interdisciplinary research effort to inform decisions about the sustainability of groundwater resources on the island of Maui under future climate conditions. A new hydrologic model is being used to assess the impact of changing climate and land cover on groundwater recharge over the island. Once results are available from this study, freshwater availability can be further evaluated and water management decisions adapted in planning for change. Preliminary predictions on future climate projections for Maui island include: 1) temperature increases at all elevations; 2) wet areas get wetter; 3) dry regions are mixed (some wetter, some drier); 4) mean annual rainfall increases (seasonal patterns show May-September drying in Central Maui); 5) Mean annual reference evapotranspiration increases; and 6) little change in cloud-base elevation and trade-wind inversion height.[10]

Acknowledging the limitations, potential reduction in available groundwater sources under drought conditions are assessed. A hypothetical "developable yield" is considered in response to community interests advocating an additional buffer to groundwater development, especially in aquifer systems where confidence ranking is low due to lack of hydrologic data. The hypothetical reduction in yield is based on current modeled reductions in recharge should be used as *guidance for pumpage levels and distribution*, not substituting sustainable yield as established by CWRM. On a 20-year time frame, changes due to climate change cannot be reliably predicted but vulnerabilities can be addressed through diversification and resource augmentation.

Table 11-2 Groundwater Availability and Drought Conditions

Aquifer Sector	Sustainable Yield (MGD)	Hypothetical Drought Yield (MGD)	Used (MGD)	Unused (MGD)
CENTRAL	26	19	62.72	36.72
KO`OLAU	175	139	0.92	174.08
LAHAINA	34	26	6.21	27.79
WAILUKU	36	25	20.76	15.24
HANA	122	99	0.61	121.39
KAHIKINUI	34	21	0	34
MAUI ISLAND	427	329	91.21	333

Water Quality

Most drinking water on the island is derived from the freshwater lens that sits above saline water. The salinity or chloride levels in fresh water are addressed in the establishment of sustainable yield: "Sustainable yield refers to the forced withdrawal rate of groundwater that

[9] Water Resources and Climate Change Adaptation in Hawai'i: Adaptive Tools in the Current Law and Policy Framework

[10] Participatory Scenario Planning for Climate Change Adaption: Final Land Use Input, Pacific RISA, November, 2014

could be sustained indefinitely without affecting either the quality of the pumped water or the volume rate of pumping." [11] Chloride levels above 250 mg/L are not considered potable quality and are regulated as a secondary, non-enforceable drinking water standard. Chloride levels must be addressed both in determining appropriate use of groundwater supply and in managing groundwater resources to prevent overdraft and increasing chloride levels over time.

Water quality is also affected by potentially contaminating activities, including agricultural, commercial and industrial land uses. Most contaminants currently detected in Maui wells are derived from legacy pesticides applied decades ago. The Safe Drinking Water Act, amended in 1996, establishes primary drinking water standards, treatment technologies and monitoring schedules. Drinking water rules are reactive to existing contamination but does not protect or prevent future contamination of drinking water sources. Avoiding contaminated aquifers or factoring in necessary treatment technologies and costs are limiting factors in groundwater development to meet potable needs. Ground and surface water supply must also be actively protected from future contamination on a state and local level to ensure sustainable water quality over time and to ensure consistency with the State Water Quality Plan prepared by the State Department of Health.

Water Loss and Other Uncertainties

Water losses due to leaks, seepage, evaporation and other inefficiencies range widely depending on storage and source transmission system age, length, type and many other factors. Water audits, improved irrigation methods and storage can mitigate but not eliminate water losses. To determine resource adequacy, demand factors are increased by 10 - 20% to account for water losses in water supply distribution and storage.

Other constraints on groundwater availability include access and cost. High yield aquifers in East Maui are located in remotely located watersheds in relation to growth areas where conveyance is difficult and transmission expensive. The Upcountry region is largely overlying the Makawao aquifer with relatively untapped yield. Elevations above 1200 feet would entail high pumping costs. To optimize pump distribution in partially developed aquifers, additional transmission to existing infrastructure may be warranted at additional cost.

Surface Water

There are 90 perennial streams on Maui, 82 of which have been diverted to some extent. Surface water supplies a relatively small proportion of drinking water island-wide but is a significant source of supply in West Maui and Upcountry. Absent established in-stream flow standards island wide, best estimates of available flow under various conditions were derived from CWRM contested case hearings data, decisions and orders, from U.S. Geological Survey studies and from data reported by diverters to the CWRM.

[11] State Water Resources Protection Plan, 2008

Reported diversions of stream flow are often double counted as gages within a ditch measures continued flow from streams diverted along the same ditch. Q_{50}, the median or natural base flow for a particular stream segment during a specified period, can be used to assess potentially available surface water during normal conditions. Base flow is dependent on groundwater discharge while total flow reflects base flow and rainfall runoff. The base flow is a general guideline for the minimal amount of streamflow needed for fish habitat. For perennial streams, the estimated long-term average base flow is 60 to 80 percent and thus 70 percent is used (CWRM Staff Submittal, Steam Diversion Works Permit (SDWP.4175.6) Wailuku River, Maui, August 16, 2016)

Q_{90} flow is commonly used to characterize low flows and flow exceeded 95 percent of the time Q_{95} represents extreme low-flow conditions. Pending outcomes of the East Maui and the Na Wai Eha contested cases and established IFS, an assessment based on best available data is summarized below. The following limitations should be taken into account:

- Many streams are not gaged and not diverted
- Many streams are diverted but not gaged or studied
- Historic diversions indicate higher uses as well as higher stream flow

Table 11-3 Surface Water Availability (MGD)

AQUIFER SECTOR	Median Flow/Q50	Low Q70	Drought Flow/Q90	Potential IFS	2009 – 2015 Average Diverted	1990 and Prior Diverted [a]
WAILUKU	67.83[b]	51.7 b	40.2 [b]	N/A	41-60	107.3
Na Wai Eha (excluding Kahakuloa Stream)	62.66	48.69	37.34	35.4 [c]	41-60	107.3
KO`OLAU	59.7	35.72	20.23	N/A	114-167	169.6
East Maui Streams in Contested Case	44.17	25.17	14.45	39.99 [d]		N/A
LAHAINA	40	31	22.44		20.21	56.2
CENTRAL	0	0	0	0	0	0
HANA	N/A	N/A	N/A	N/A	N/A	0.1
KAHIKINUI	N/A	N/A	N/A	N/A	N/A	0.1
MAUI ISLAND	169.18	119.74	84.24		175.21 - 247.21	333.3

a. Department of Water Supply, Maui County Water Use and Development Plan, March 1990
b. USGS 2016-5103
c. CWRM 2010 decision
d. CWRM Hearing Officer Decision 1/15/16

As discussed under section 5.6, the availability of surface water is uncertain due to multiple factors, including lack of measured flow data, pending instream flow standards and ongoing contested cases. Other threats to surface water resources are drought and climate change, invasive animal and plant species disrupting native ecosystems.

Drought and Climate Change

Decreasing rainfall, whether as a result of long term droughts or climate change, has more immediate impacts on surface water flows making surface water vulnerable and generally less reliable over short terms than groundwater. The Hawaii Drought Plan, 2005 Update, identifies water supply vulnerability areas, including most of Upcountry Maui. A hydrological drought refers to deficiencies in surface and subsurface water supplies, which are reflected in declining surface and ground water levels when precipitation is deficient over an extended period of time.[12] For the drought scenario, stream flow-duration discharges that are equaled 95 percent of the time (Q_{95} flow; or Q_{90} if Q_{95} flow not determined) are considered in evaluating surface water availability. Outdoor demand is assumed to increase, especially in agricultural vulnerability areas, but mitigated by continued and more aggressive conservation initiatives.

Water Quality

Land disturbance and erosion cause sedimentation and turbidity in streams, which indirectly increase filtration treatment costs. Surface water for potable use is subject to the Surface Water Treatment Rule of the SDWA as amended. The primary threats to the watershed as a whole is invasive plant and animal species that outcompete the native ecosystem, potentially impacting recharge and exacerbate erosion. Few streams traverse agricultural and urban areas but ditch conveyance systems above ground from stream intakes can introduce agricultural pesticides and urban chemicals. EPA rules establish required treatment technologies, disinfection and monitoring schedules to address microbial contaminants typically associated with surface water, including Total Coliform *(E.coli) Legionella*, *Cryptosporidium*, and *Giardia lamblia*. The presence of organic matter in surface water adds another challenge in drinking water treatment. Organic materials react with disinfectants to form disinfection byproducts (DBP) in the distribution system. Additional carbon filtration technologies may be warranted in addition to conventional filtration systems. The U.S. EPA promulgated the Disinfection Byproduct Rule to provide more consistent protection from DBPs across the entire distribution system and by focusing on the reduction of DBP peaks

Water Loss and Other Uncertainties

Water losses from open unlined ditches and raw water reservoirs are generally higher than from groundwater sources. Raw water storage in plantation and municipal reservoirs are subject to state rules established by the State Department of Land and Natural Resources and stricter insurance requirements. The liability and associated costs may impede construction or refurbishment of existing privately owned raw water reservoirs.

Due to the interconnectedness of groundwater and surface water in terms of high level or basal groundwater recharge to streams and stream seepage to groundwater, future development of groundwater sources in certain areas may potentially impact stream flow. The CWRM has jurisdiction over well drilling and any potential impacts on stream flow. However, where hydrologic data is scarce, additional hydrologic studies may be warranted to assess impact of major groundwater developments.

[12] WRPP, 2014, Drought Planning (Draft)

11.2 ALTERNATIVE WATER SOURCE AVAILABILITY AND UNCERTAINTIES

Developing and promoting alternative supplies to ground and surface water furthers diversification of supplies, conserve water resources and hedge against droughts and climate change. Alternative supply are generally not cost efficient per se, but can be important in areas where potable water is not available in sufficient quantities or areas lacking municipal infrastructure.

Recycled Wastewater

The Department of Environmental Management (DEM) administers and operates the county wastewater treatment plants and recycled water distribution system. As urban growth areas are developed in Central, South and West Maui, additional recycled water will become available at the same time as non-potable demand increase. The table below summarizes potentially available recycled capacity based on Verification Studies for the county facilities and current customer services and project improvements. DEM must fulfill obligations to serve projects that are in close proximity to the existing distribution system and will be connecting in the near future. The cumulative peak demand from these projects combined with existing demand cannot exceed recycled water produced. When demand is low, generally in the wet winter months, the excess wastewater must still be disposed of. Full utilization of recycled water production will supplement demand in West and South Maui and mitigate effluent disposal to injection wells. However, planned expansion of distribution from the Wailuku-Kahului facility has by far the greatest potential to offset potable water resources while reducing effluent discharge to injection wells and preserving brackish water resources. Plans for a distribution line build-out to HC&S lands east of Kuihelani Highway could offset irrigation demand on portions of the 1,951 acres of HC&S lands currently slated for "Large Diversified Farm Leases". The Central Maui recycled water distribution system has not been developed to date because the majority of candidate commercial properties currently utilize inexpensive brackish or ditch water.[13]

Table 11-4 Summary of Recycled Water Available Capacity

WWRF	Aquifer Sector	Treatment Level	Design Capacity (MGD)	Recycled Water Produced (MGD)	Recycled Water Sold (MGD)	Cumulative Peak Demand, Current and Committed Projects	Remain Available
Kihei WWRF	Central	R-1	8	3.65	1.25	2.4	0.77
Lahaina WWRF	Lahaina	R-1/R-2	9	3.84	0.88	1.97	1.86
Makena WWRF (Private)	Central	R-1	0.75	0.08	0.08	0.08	0
Pukalani WWRF	Central	R-1	0.285	0.19	0.19	0.19	0

[13] 2010 Central Maui Reycled Water Verification Study

(Private)							
Wailuku-Kahului WWRF	Central/ Wailuku	R-2	7.9	0.25	0.00	0.25	4.2
Haleakalā closed-loop system (and rain water)	Central			0.185		N/A	N/A
Total			26.33	8.19		4.89	6.83

Rainwater Catchment

Catchment systems on island are generally individual households using rain barrels or other devices to collect rainwater from a roof. Rain catchment systems are not regulated by the Department of Health and water quality can be an issue. The DOH Safe Drinking Water Branch publishes guidelines on how to design, construct and maintain home systems safe for domestic use. Scattered use occurs primarily in East Maui where there sufficient rainfall make catchment systems feasible. Impacts from seasonal droughts and climate change are unknown. However, households served solely by catchment systems may require back up sources, such as shared domestic wells.

Determining appropriate system sizing requires an accurate analysis of water demand relative to precipitation patterns.[14] The feasibility of using catchment for domestic use depends on demand, catchment area such as roof area, rainfall patterns and storage capacity. Scenarios presented below include an average demand of 100 and 200 gallons per household per day, or about 3,000 and 6,000 gallons per month. This is compared to the 600 gallon per day (18,000 gallons per month) single-family standard for public water systems which would be adequate for incidental outdoor irrigation. Finally, an agricultural scenario consisting of 0.5 acre of diversified crops is provided. To ensure a year-round water supply for domestic use, the catchment area and storage capacity must be sized to meet water demand through the longest expected interval without rain. In some areas on Maui historic intervals without rain have exceeded three months. Designing for this interval means that storage should meet average quarterly demand, although this approach may result in a more expensive system due to higher storage costs.[15] Reducing demand along with water hauling could offset lack of supply during dry periods. The scenarios below show how much rainfall would be collected based on catchment area and rainfall, storage required to meet monthly demand, and then the amount required to meet a 90 day demand. Rainfall (low to high) is similar to averages for the Kahului, Pukalani and Haiku areas, respectively. Catchment in areas with higher rainfall continuing eastward of Ha`iku should increase in viability. Water needs for diversified agriculture provide a

[14] US EPA. *Rainwater Harvesting- Conservation, Credit, Codes, and Cost Literature Review and Case Studies,* January 2013, pp. 3-4.

[15] Texas Water Development Board. *The Texas Manual on Rainwater Harvesting*. Third Edition 2005, pp. 31-32. Median rainfall is more conservative and provides higher reliability than average rainfall because large rainfall events tend to drive the average value higher.

rough sense of potential requirements based on the limited assumptions presented, and do not take into account the effects of irregular rainfall, the need for large and reliable volumes of water at the time needed, market conditions, etc.

Table 11-5 Rainwater Catchment Scenarios

Scenarios	Demand (gpd)	Demand (gal/ month)	Catchment Area (sf)	Rainfall (monthly average)	Rainfall Collected	Storage Required (30 day)	Storage Required (90 day)
25 gpd, 4 people	100	3,000	2,500	1.5	1,986	5,000	10,000
25 gpd, 4 people	100	3,000	2,500	4.0	5,296	5,000	10,000
50 gpd, 4 people	200	6,000	2,500	4.0	5,296	10,000	20,000
600 gpd/residential unit	600	18,000	2,500	6.0	7,943	20,000	55,000
Accessory ag, 0.5 acre, 3400 gpa	1,700	51,850	10,000	6.0	31,773	60,000	160,000

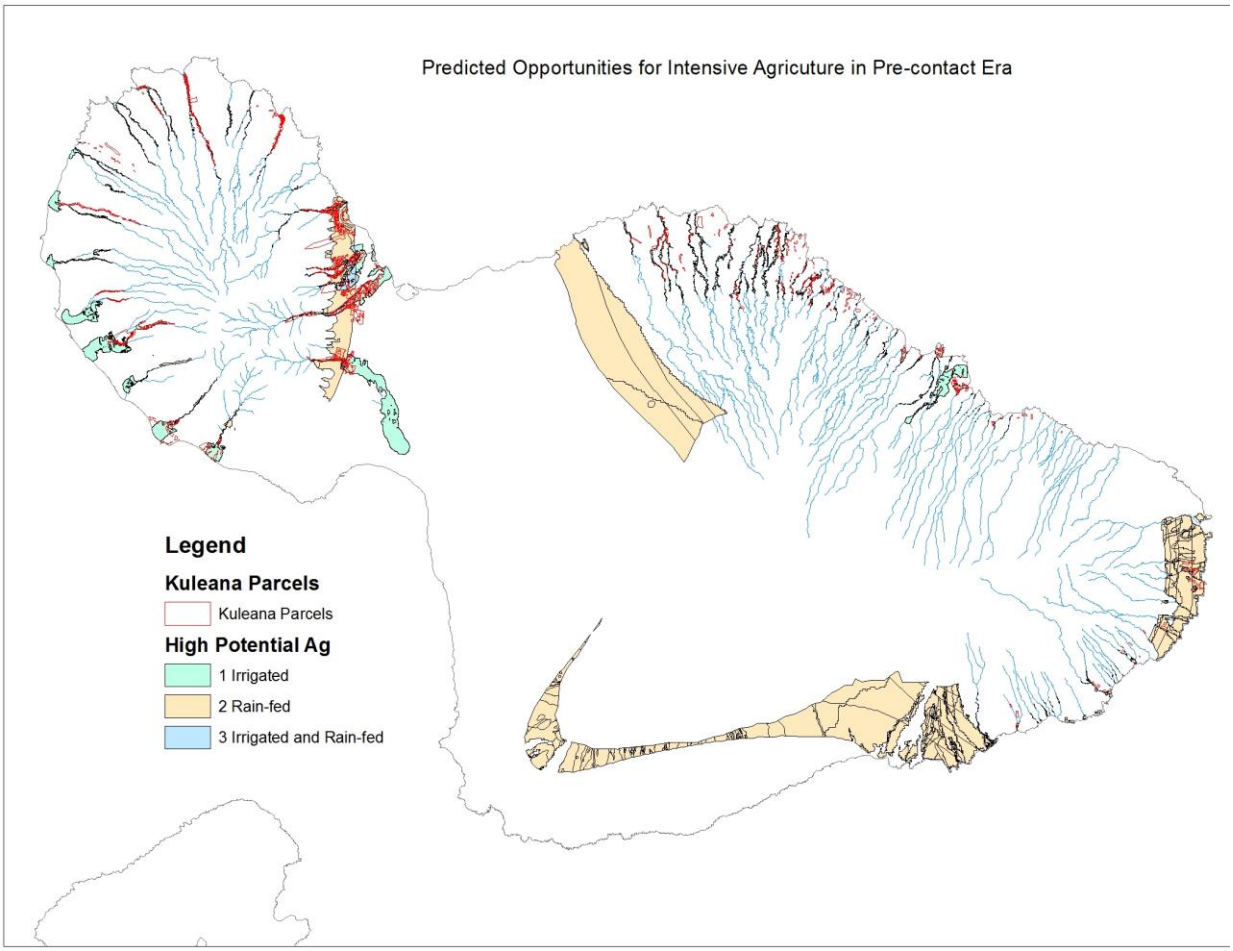
Storage is rounded up to the nearest 5000 gallon volume.
Rainfall (inches) x catchment area x 0.623 gal/sq ft /in. rain x 85% collection efficiency

Agricultural crops have different requirements for water quality. Support for increased adaptation to natural ambient rainfall and climate adapted crops is consistent with the objective to use appropriate water quality for appropriate uses. To reduce demand for off stream uses of surface water, rainwater catchment for diversified agriculture could potentially increase. Where ambient rainfall can adequately satisfy agricultural demand during normal rainfall conditions, conventional resource use including surface and ground water can be used solely as contingency.

Drawing from history, indigenous Hawaiians were highly effective cultivators. A study of the suitability of tropical lands for sustained intensive pre-European contact agriculture modeled the distribution of irrigated taro pondfields and rain-fed dryland systems (largely sweet potato and to a lesser extent dryland taro, yams, banana, sugar cane, and other crops) based on climate, hydrology, topography, substrate age, and soil fertility, and comparison with archaeological evidence. Focusing here on rain-fed dryland systems which are more constrained, annual rainfall for optimum intensive rain-fed sweet potato production was defined in the study as a 30 inches per year, with 20 inches in the growing season being a minimum.[16] (pp. 1-3) For Maui Island, the model predicts four major zones of high potential for rain-fed field systems, and these are verified by other information.[17]

Figure 11-1 Predicted Opportunities for Intensive Agriculture in Pre-contact Era

[16] Ladefoged, T.N., et al., *Opportunities and constraints for intensive agriculture in the Hawaiian archipelago prior to European contact*, J. Archaeol. Sci. (2009), doi:10.1016/j.jas.2009.06.030, pp. 1-3.
[17] Ladefoged, T.N., et al., *Opportunities and constraints for intensive agriculture in the Hawaiian archipelago prior to European contact*, J. Archaeol. Sci. (2009), doi:10.1016/j.jas.2009.06.030, pp. 8-9.



Stormwater Reuse

Development that increases the amount of impervious surface in stormwater catchment areas decreases infiltration and thereby groundwater recharge. Green stormwater infrastructure can remove harmful pollutants in stormwater through filtration, biological uptake and breakdown while retaining stormwater volumes. Stormwater reuse provides for capture and reuse of surface water runoff. Due to contaminants picked up by stormwater runoff, different levels of treatment may be necessary. Stormwater can carry sediment, nitrogen, phosphorus, metals and pesticides that impact streams and near-shore coastal waters. Reliability is an issue as the supply does not match demand. Stormwater is not managed by water utilities but are generally funded through county general funds to ensure regulatory compliance. Regulations primarily address pollutants in stormwater runoff. Maui County Code Title 15 governs the design of storm drainage facilities and best management practices. Low Impact Design techniques that mimic predevelopment hydrology can be included in site design to satisfy water quality for stormwater runoff. However, reuse as the next step in stormwater management is not implemented to a great extent despite its multiple benefits. Four stormwater reclamation opportunities for agricultural irrigation end uses on Maui were

appraised in a statewide study: Waiale Road Stormwater Drainage to collect stormwater from an urban area including an large detention pond; Kahoma Stream Flood Control to collect stormwater from a drainage channel; Kahului Flood Control Channel to collect stormwater from drainage channels; and Lahaina Flood Control to collect stormwater from a drainage channel and detention pond. [18] None of the stormwater reclamation projects are currently implemented. The most effective stormwater management techniques are practiced at the source of runoff. "Clean catchment" is where velocities are the lowest, quantities is the smallest, and quality is the least impaired. The table below presents typical domestic water uses that could potentially be supplied from reclaimed stormwater. [19]

Table 11-6 Stormwater Applications for Domestic Uses

Water Use	Rate	Number of Events*	Total Usage, Gallons/year
Car washing	116 gallons/wash	90 washes	10,440
Lawn watering	180 gallons/application	58 waterings	10,440
Toilet flushing	4 – 7 gallons/flush**		6,000 – 10,500

*Based on Lahaina which represents the lowest rainfall capture potential
**Assuming non-water conserving toilet using 7 gallons per flush

Desalination

Desalination of brackish water is generally more cost-effective and environmentally-friendly than use of sea water. The effects on groundwater resources and chlorides due to anticipated reduced irrigation association with the cessation of sugarcane production are issues. Salinity would slowly increase with time if recharge from surface water irrigation ceases. A reasonable estimate for the isthmus for planning purposes is less than 100% (from current average of about 400-500 mg/l to 800-1000 mg/ chloride) over a time period of 5 to 10 years. The most critical recovery-limiting constituents are silica, calcium and barium, pH, alkalinity and temperature. A broad range of other constituents affect processing. Trace amounts of pesticides have been found in some irrigation wells in the Kahului Aquifer and brackish wells may contain the same pesticides that would potentially require activated carbon filtration and add to treatment costs.

Treatment technologies for both brackish and sea water desalination were evaluated for Central and South Maui. Feasibility of a disposal option depends on many factors including climate, land availability, hydrogeology, regulations, public perception, and other. The primary environmental concern is impacting waters suitable for use as potable source water, and wastewater disposal injection wells are continuously an issue on Maui. The central Maui area

[18] U.S. Department of the Interior, Bureau of Reclamation: An Appraisal of Stormwater Reclamation and Reuse Opportunities in Hawaii, 2008
[19] Commission On Water Resource Management, A Handbook for Stormwater Reclamation and Reuse Best Management Practices in Hawaii, December 2008

where possible desalination plant sites are located fall within this area where the underlying aquifer is not considered a drinking water source. Drilling the wells deep enough should avoid challenges with future more stringent regulations for injection wells.

If seawater desalination were used, deep well intake sites for sea water desalination are preferred over coastal subsurface and surface ocean intake alternatives, with conveyance of the concentrate (brine) to an ocean outfall system. However, the high salinity (71,000 mg/L) of the brine raises environmental concerns with the effect of salinity on marine organisms.

11.3 LAND USE BASED FULL BUILD-OUT DEMAND PROJECTIONS

Full build-out under County Zoning and DHHL land use plans would result in a hypothetical maximum demand of 931 mgd. The full-build-out scenario would exceed the island sustainable yield and assessed available surface water if demand was supplied entirely by conventional water resources. The land use based full build-out scenario is considered unrealistic because it is not coordinated with population projections which also take into account forecasted economic conditions over the planning period. Ultimate build out of Agricultural zoned land also does not accurately reflect anticipated use and water demand for Agricultural lands. Refined projections that account for historic and current agricultural use and crop specific water rates probably result in more realistic water demand. For example, 71% of all land currently in agricultural use island-wide, are unirrigated pasture, relying on natural rainfall. About 27,000 acres, or less than 18% of all land currently in agricultural use, is designated as Important Agricultural Lands (IAL). The potential for increased agricultural demand also appears to be unsupported by market trends, as well as the legal environment which constrains availability of surface water resources. Demand resulting from build-out of farm dwellings on Agricultural zoned land is more accurately represented by projected population growth over the 20-year time horizon of this plan.

11.4 POPULATION GROWTH BASED WATER DEMAND PROJECTIONS (20-YEAR)

Projecting water demand for population growth is inherently uncertain. Economic markets and housing influence water system growth. Water use does not strictly correlate to population growth but largely depends on household size and water use behavior. Between 2015 and 2035, population based demand is projected to increase from about 42 mgd to approximately 62 mgd, a projected increase of about 47% or 20 mgd based on Community Plan growth rates applied to existing demand. The projected range of 2035 demand is about 53 to 67 mgd. The range in 2035 population growth based demand encapsulates the most probable scenario of continued and intensified conservation measures. It is assumed that potable demand for State Projects and Department of Hawaiian Homelands are accounted for in the socio-economic forecast and therefore projected population growth.

11.5 AGRICULTURAL DEMAND PROJECTIONS

Non-potable agricultural irrigation demand is not coordinated to population growth and represent additional demand as discussed under the Alternative Agricultural Scenario. The selected demand scenario combining 20 year population growth, Department of Hawaiian Homelands non-potable uses, non-potable needs for kuleana and lo`i kalo, projected diversified agricultural use on HC&S lands, and projected agricultural use outside the HC&S plantation are summarized below. The intensity of use and timing of new crops on HC&S lands has by far the largest variation potential as economic markets, the availability of surface water and pilot testing of economically viable crops directly impact irrigation needs.

Table 11-7 Summary of Demand Projections

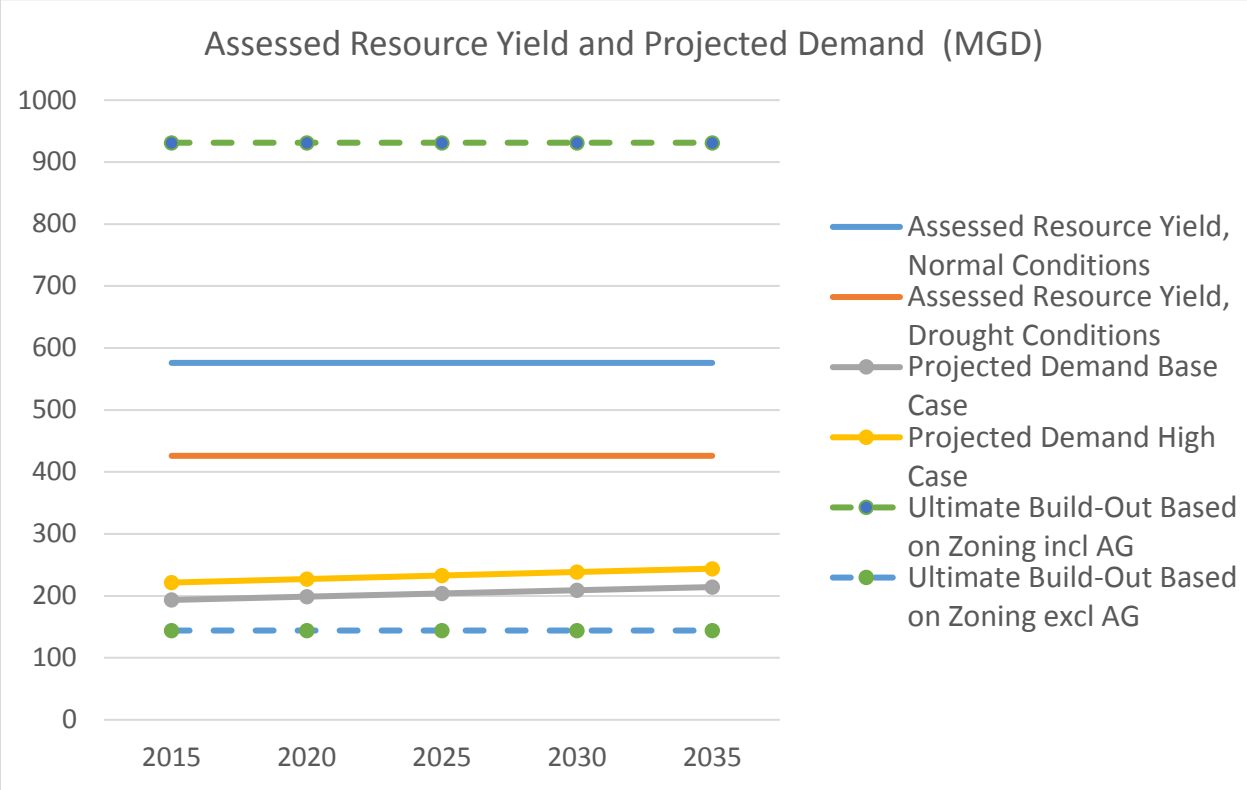
DEMAND	**2015**	**2035**
Population growth based, Base Case	42.6	62.8
Population growth based, 8% per capita conservation target	42.6	53.2
Population growth based, Low	42.6	57.4
Population growth based, High	42.6	67.7
Non-potable demand:		
Kuleana and kalo lo'i	10.9	15.5
Department of Hawaiian Homelands	1.87	11.6
HC&S lands Diversified Agriculture	295.4	116
Diversified Agriculture, outside HC&S plantation	20.9	25
TOTAL RANGE:	371.2	221 – 235.9

The assessment of available resources and analysis of projected demand confirm that there is sufficient water island wide to meet 20-year projected growth, including the estimated range of agricultural irrigation demand, under normal and drought conditions. Full build-out based on current zoning including Agricultural zoned land, if assumed to be fully utilized and irrigated, is not supportable without significant development of alternative water resources. A full build-out scenario is highly unlikely on a 20 year time frame. However, entitlements and proposed projects are instructive as to location and planning for water sources. Department of Hawaiian Homelands projected demands should be considered in terms of resource use and transport.

Water resources are shared both naturally as hydrogeological units cross community plan boundaries, and mechanically where resources are transported between hydrologic and community plan regions. Demand and resource use in Central, Ko`olau and Wailuku regions impact each other as water is transferred from where it is to where it is needed. Domestic water supply systems are primarily supplied by groundwater to meet future demand. Agricultural demand is primarily dependent on surface water supplies subject to IFS to satisfy instream, including kuleana, needs and improved efficiencies to reduce water losses and alternative supply in periods of drought. It should be emphasized that kuleana irrigation needs

are not consumptive as much of the water flow through the lo'i kalo is returned to the stream. Island wide, about 57% of available conventional water resources could meet 2035 demand under drought conditions.

Figure 11.2 Assessed Resource Yield and Projected Demand



For each aquifer sector, water demand based on full build-out of zoning designations and 5-year incremental demand based on population growth are compared to the available conventional and alternative water resources. Available water resources include ground water, surface water, rainwater, reused rainwater (stormwater, catchment), recycled wastewater and greywater, and desalinated water. The availability of each resource is contingent on several factors and uncertainties addressed in Section 12 Strategies below.

11.6 DROUGHT SCENARIO DEMAND PROJECTIONS

The Hawaii Drought Plan, 2005 Update, identifies water supply vulnerability areas including Upcountry, Keokea and Kahikinui, and agricultural vulnerability areas as Kula, Ulupalakua, Lahaina, Central Maui, and Kahikinui. The Maui Drought Committee identifies Upcountry (Kula, Makawao, and Pukalani to Kaupo) as particularly at risk for drought. Historically, agricultural demand and landscape irrigation increase by about 20% during drought conditions. Island wide, water resources during drought conditions can meet a hypothetical 20% increase in demand, even under the high growth scenario. However, to adequately address water supply

vulnerability areas such as Upcountry, a diversified supply, creative storage and targeted conservation are needed to provide consistently reliable supply.

11.7 SOURCE CAPACITY PROJECTIONS

To meet projected demand in each region and aquifer sector, source development, whether conventional or alternative, must consider peak water use and water distribution losses including unauthorized use and unmetered use. Water production data, including treatment plant production and well pumpage are higher than billed consumption data. Optimization studies completed in 2013 for the MDWS Central Maui System, the Upcountry System and the Lahaina System based source development needs on the peak month production for each system. For the Central-South MDWS system, source development needs accounted for an additional 20 percent to projected base water use. For the Upcountry system the average and peak demand are much more volatile with peak daily demand 58 percent higher than average production over a ten year period. The source development needs considered low rainfall periods and applied 31.5 percent adjustment to projected base water use. For the Lahaina MDWS system, 29 percent was added to projected base water use to account for peak production of ground and surface water supply. For other MDWS and public water systems, twenty percent added capacity to population growth based water use demand can represent peak seasonal use for conventional resource development.

The unaccounted for water, or water losses, varies for MDWS systems and is unknown for other public water systems. The average water loss for MDWS systems is about 13 percent and considered included in peak production data. Strategies for surface water conveyance through unlined plantation ditches and reservoirs are higher with 20 to 22 percent losses considered reasonable for plantation systems in the East Maui Streams and Na Wai `Eha contested cases.

12.0 STRATEGIES

In this section, recommended strategies were selected from preliminary strategies considered in developing the WUDP and vetted throughout the public process. These include measures, programs, policies and improvements that a. Address identified issues and concerns, 2. Meet one or several established planning objectives and 3. Reflect the values and guiding principles distilled during the community outreach process. The strategies are consistent with the overall goals and objectives defined in the Maui Island Plan. The overall goals related to water resource use and management adopted in the Maui Island Plan are:

- Healthy watersheds, streams, and riparian environments.
- Maui will have an environmentally sustainable, reliable, safe and efficient water system

The planning objectives adopted in the Maui Island Plan and the community plans and further defined in the WUDP update process form the basis for identified and selected resource strategies. Many of the issues and challenges related to water resource and supply in the Maui Island Plan are specific to the County Department of Water Supply systems. Some preliminary strategies were mutually exclusive, or complementary to meet projected demand and multiple planning objectives. Through community meetings and consultations with stakeholders and government agencies, region specific issues were further defined and preliminary strategies to address the issues were suggested. The Regional Plans articulate region specific sub-objectives to address such issues.

Comparative costs over a 20 year life cycle are assessed or estimated in order to compare and roughly characterize conceptual resource strategies. Accurate determination of cost would require more precise information on timing, site location, specific circumstances and operations. For example, the cost of developing, pumping and distributing water from a well site is highly dependent on the well depth and wellhead elevation, the water quality encountered and related treatment, the end use service area location and elevation and other factors.

A combination of several preliminary strategies were selected that align with planning objectives, are feasible considering hydrologic and legal constraints, cost effective to adequately meet projected demand while balancing the needs of the community. Resource management and water supply development strategies can represent existing programs or concepts to be further assessed and developed.

The overall Planning Objectives listed below can also be qualified using the criteria or benchmarks provided in section XX to measure accomplished targets in plan implementation.

1. Maintain sustainable resources
2. Protect water resources
3. Protect and restore streams
4. Minimize adverse environmental impacts
5. Manage water equitably
6. Provide for Department of Hawaiian Homelands needs
7. Provide for agricultural needs
8. Protect cultural resources

9. Maximize water quality
10. Maximize reliability of water service
11. Maximize efficiency of water use
12. Minimize cost of water supply
13. Establish viable plans
14. Maintain consistency with General and Community Plans

12.1 RESOURCE MANAGEMENT

An important purpose of this document is to provide a viable plan to equitably meet the water needs of all users on Maui Island in a sustainable way consistent with state and county laws, policy and the planning objectives of this plan, which reflect local issues and principles. Resource management is a key component of these objectives, focusing on both water sources (supply side) and their use (demand side).

Management Lessons from History

The ancient Hawaiians understood that every element within the *ahupua'a* was related to each another. Through the sharing of resources and working within the rhythms of their natural environment, the ancient Hawaiians were able to sustain large numbers of people, estimated to have numbered approximately one million inhabitants prior to European contact. The ahupuaʻa system reserved valley floors, where the most fertile soil is located, for communal food production. Hawaiians developed agroforestry systems that minimized soil erosion, facilitated the emergence of water springs, and maintained high species diversity. Population pressure and immigration continue to change both Hawaiian ways and the island environment. The ahupuaʻa system supports ecosystem health and sustainability, as well as ecosystem resilience which is important to tackling challenges such as changing climate and effects on ground and surface water systems in the face of increasing demands on water resources.

The cultural ahupuaʻa system is perpetuated through the modern principle of sustainability and ecosystem-based stewardship. The cultural concept of malama `aina—or caring for the land—can be facilitated by integration of traditional ahupuaʻa district planning with modern watershed and ecological planning, as well as fostering community responsibility to participate in planning and management efforts. The terms “ecosystem approach” and “watershed approach” have become synonymous with ahupua'a approach in the literature and programs addressing watershed protection.[20]

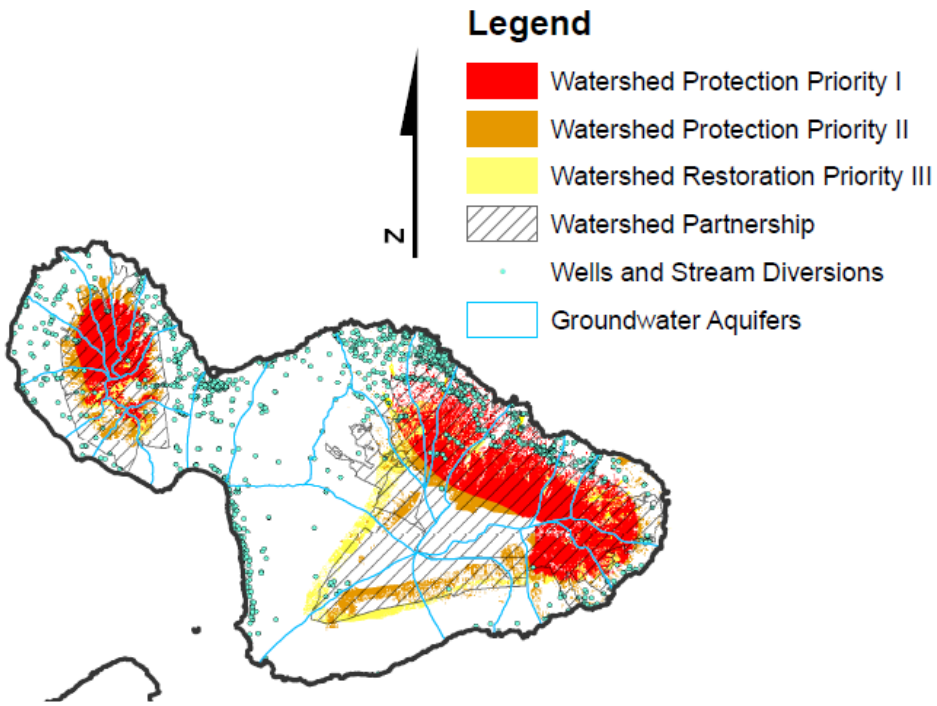
Watershed Management

In 2011 the DNLR introduced “The Rain Follows the Forest” watershed initiative which aims to preserve and protect Hawai'i’s mauka watersheds as a source of fresh water and a home to native Hawaiian species focused on removing invasive plant and animal species and in some

[20] Atlas of Hawaiian Watersheds and Their Aquatic Resources. http://Hawai'iwatershedatlas.com/intro_watersheds.html

cases building protective fences. The DLNR has identified "Priority Watershed Areas" which are areas of highest rainfall and resupply, based on climatic conditions that provide high recharge and fog capture as shown in Figure 11-2. The State and County as well as various other entities have initiated or continued a variety of watershed based programs, increasingly focused on partnerships.

Figure 12-1 Priority Watershed Areas



The Rain Follows the Forest, DNLR, 201

Watershed Related Issues

The foundation for sustainable water resources is a healthy watershed that supports groundwater recharge, stream flow and healthy coastal and near shore waters for future generations. The observed trends of increasing temperatures, decreasing rainfall and declining streamflow have implications for watersheds and forests, water supply and quality, and dependent uses. Forested watersheds recharge groundwater supply, infiltrate rainfall and slow down runoff, mitigating flooding, control erosion and runoff to the ocean, protecting coral reefs and fisheries. Native forests provide habitat for unique plant and animal species and supply culturally important plants and animals. Constant threats of invasive and ecosystem modifying animal and plant species necessitate active management of native forested watersheds to maintain a functioning water collection system and important ecosystem services. Invasive plants and feral ungulates are considered the most damaging threats. Cattle, pigs, goats, sheep and deer destroy forest vegetation leaving grounds bare and soils exposed. Invasive wee species can take over a native forest and impact its efficacy in water collection, wildfires, and

forests pests and disease. [21] Invasive species in the streams also out compete and impact native aquatic species. Wildfires contribute to degradation of the forested watershed if invasive species are allowed to re-vegetate burnt areas. Watershed management is largely focused to the high elevation forested areas. Management using traditional ahupua`a, or ridge to reef approach is hampered by urbanization, agricultural lands and fragmented ownership.

Objectives

a. Maintain Sustainable Resources, Protect and Restore Streams and Cultural Resources
b. More comprehensive approach to water resources planning to effectively protect, recharge, and manage water resources including watersheds, groundwater, streams, and aquifers.

A key value distilled through community input and participation is that water resource planning and solutions should support ecological, social and financial sustainability. Watershed protection generally strives to prevent the creation of new contaminant sources or threats to source waters while watershed management generally aims at reducing or eliminating contamination sources or threats. Watershed management is a first line of defense or protection barrier to the potential transmission of contaminants to water supply, with treatment a secondary or complementary action to ensure safe drinking water. As surface water is inextricably linked to groundwater, resource management on a watershed or ahupua`a level, provides a holistic approach to address and ensure long term viable water quality.

General Plan Policies

a. Perpetuate native Hawaiian biodiversity by preventing the introduction of invasive species, containing or eliminating existing noxious pests, and protecting critical habitat areas.
b. Restore and protect forests, wetlands, watersheds, and stream flows, and guard against wildfires, flooding, and erosion.
c. Protect baseline stream flows for perennial streams, and support policies that ensure adequate stream flow to support native Hawaiian aquatic species, traditional kalo cultivation, and self-sustaining ahupua`a.
d. Restore watersheds and aquifer-recharge areas to healthy and productive status, and increase public knowledge about the importance of watershed stewardship, water conservation, and groundwater protection.
e. Promote the use of ahupua'a and moku management practices.

Recommended Strategies

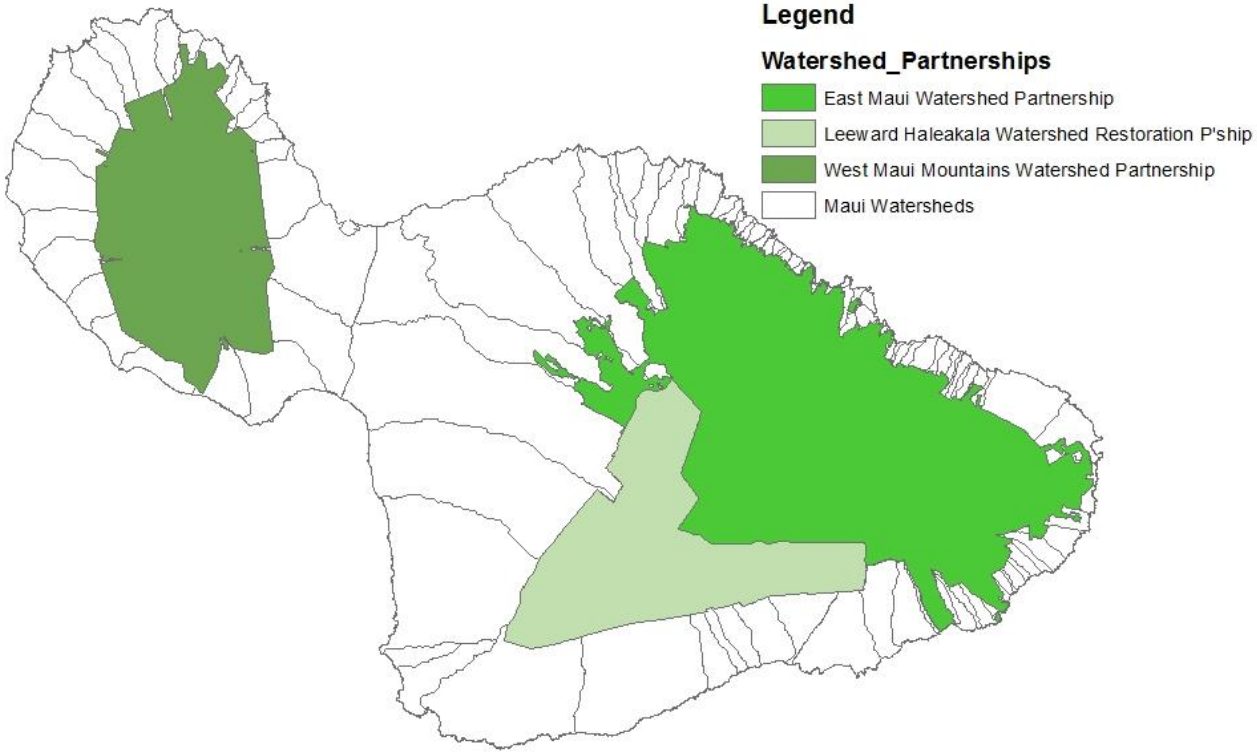
a. Continue Maui County financial support for watershed management partnerships' fencing and weed eradication efforts.

[21] http://hawp.org/why-watersheds-matter/

The County's watershed protection approach provides a strategy for effectively protecting and restoring the resilience of natural aquatic ecosystems and thereby protecting ground and surface water resources and a range of ecosystem services. The approach is based on the premise that many water quality and ecosystem problems are best solved at the watershed level, rather than at the individual body of water or point of discharge. The watershed management approach fosters partnerships that involve the people most affected by allowing them to participate in key management decisions. This ensures that environmental objectives are well integrated with cultural, social and economic goals.[22]

Maui County has taken a lead role state wide in prioritizing and funding watershed protection efforts. Water rate funded financial support through the Maui DWS to watershed partnerships since the mid 1990s addresses the primary threats to a viable fresh water supply: feral ungulates and invasive weeds. Today seven partnerships and non-profit organizations manage and monitor 346,000 acres of critical watersheds throughout Maui and Moloka'i. Watershed management plans are developed for priority watersheds and implemented by the following partnerships and non-profit organizations on Maui:

Figure 12-2 Watershed Partnerships Maui Island



[22] Water Resources Protection Plan, 2008.

East Maui Watershed Partnership

The East Maui Watershed consists of approximately 120,000 acres and provides the largest harvested source of surface water in the state. Ongoing efforts to protect the watershed include fencing, ungulate control, invertebrate and small mammal control, weed management, rare species protection, removal of invasive species, monitoring, education, public outreach and volunteer recruitment to repair and install fencing, and plant native species.

The Nature Conservancy: Waikamoi Preserve and Kapunakea Preserve

The Kapunakea Preserve in West Maui is home to Kapaloa and Honokowai streams and the pristine headwaters of the Honokowai and Wahikuli watersheds. These watersheds have been identified as focal priority watersheds by the Hawai'i DOH, EPA and NOA. Management activities include fence maintenance, ungulate and weed control, monitoring and research for the Kapunakea Preserve. The Waikamoi Preserve contains large native-dominated areas that are free of habitat modifying weeds. The Nature Conservancy not manages significant new portions of the Upper Kula water system drainage area, This project not only benefits 1,000 new acres being fenced and managed for the first time but also the entire 12,000 acre core East Maui watershed and water collection area. The 3,721 acre parcel became legally protected under a new perpetual Conservation Easement between East Maui Irrigation Co., Ltd (EMI) and TNC in April 2014.

West Maui Mountains Watershed Partnership

Over 47,321 acres of the West Maui Mountains is being protected and preserved. This watershed is a key water recharge area that provides potable water to West and Central Maui residents. The major threats to this watershed are feral ungulates, invasive weeds, human disturbances and wildfires. Ongoing efforts include ungulate control through fence construction, retrofitting and regular trap checks weed management, planting and enclosures, monitoring, and human activities management through outreach, education and curbing use of area

Leeward Haleakalā Watershed Restoration Partnership:

The partnership protects and restores dry forest lands on Leeward Haleakalā. Ongoing efforts include to preserve and provide a reserve from which certain important forest species can recover, install fencing, increase productive vegetation using native species, broadcast seed, conduct biological survey, and recruit volunteers to help with an intensive labor effort.

Auwahi Forest Restoration Project

This initiative actively restores dry forest lands on Leeward Haleakalā through excluding grazing animals, control of non-native kikuyu grass, and planting closely spaced, rapidly growing native shrubs. Efforts support hydrological research to assess the effects of native forest restoration on soil moisture dynamics and potential aquifer recharge.

Pu`u Kukui Watershed Preserve

Over 8,600 acres of Puu Kukui Watershed Preserve is being protected and preserved. Ongoing

efforts include ungulate control through fencing, trapping and surveying on foot, invasive plant control, rare species protection research and water quality testing.

Figure 12-3 Ungulate Control Through Fencing in Pu`u Kukui

Photo Credit: Pu'u Kukui Watershed Partnership

Maui Invasive Species Committee

Support efforts to monitor and remove the spread of miconia through repeated removal, treatments of existing areas of growth and prevention of seed dispersal. Similarly, manage other target weeds, including pampas grass, fountain grass, ivy gourd, giant reed, rubber vine, Jerusalem thorn, *malabar malestome,* downy rose myrtle, ruby salt bush and others. Seek to detect, identify and control potential problem weeds before they become difficult to control

b. Promote increased distribution of funding for watershed protection and active reforestation to reflect multiple values and ecosystem services.

A strong and consistent funding mechanism on state and county level would allow expanded efforts in disturbed watershed areas and address invasive threats before they become established and more difficult and expensive to combat. Water rate funded support is based on the scientific and economic underpinnings of groundwater recharge and a viable freshwater system. However, watersheds are critical infrastructure that provides a myriad of other ecosystem services, environmental and economic benefits to all citizens which warrant additional funding. Watershed restoration through reforestation of a damaged and disturbed landscape has proven successful on a small scale and is strongly supported based on community feedback in the WUDP public process. The collaboration

between watershed managers, landowners and public volunteers to restore native habitat at Auwahi is a role model statewide.

Figure 12-4 Forest Restoration and Exclusion of Grazing Animals

Auwahi Reforestation Project

c. Expand watershed protection to incorporate the ahupua`a as a whole and utilize ahupua`a resource management practices.

Ahupua`a management complement existing watershed protection efforts to include the low elevation lands, coastal zone, near shore waters and coral reefs. Traditional resource management concentrates on the perpetuation of water, agriculture, aquaculture, near-shore and ocean practices that focuses on the sustainability of the resource. [23] Initiating and promoting collaboration between county and state agencies and the Native Hawaiian communities, organized in mokus, can further the practices and applications of ancient knowledge and traditions in resource management. Traditional resource management translates to adaptive management where policies are designed and implemented incrementally to respond to new information and the behavior of natural systems. As vital information on the impacts of resource management and use are still lacking in many areas,

[23] Excerpt from the "Final Report of the Aha Ki`ole Advisory Committee, Best practices and specific structure for the cultural management of natural resources in Hawaii, December, 2008)

the WUDP strategies should be assessed and adjusted as warranted as additional traditional knowledge and data are garnered.

New partnerships and collaborative efforts can be modeled upon the West Maui "Ridge to Reef" Initiative. The Initiative encompassing 24,000 acres from Kā`anapali northward to Honolua and from the summit of Pu`u Kukui to the outer reef seeks to restore and enhance the health and resiliency of West Maui coral reefs and near-shore waters through the reduction of land-based pollution threats from the summit of Pu`u Kukui to the outer reef, guided by the values and traditions of West Maui. In July 2008 the U.S. Army Corps of Engineers (USACE) expressed interest in developing a West Maui Watershed Plan with the assistance of the DLNR, DOH and various other federal agencies. The Hawai'i Coral Reef Strategy identified the coral reef ecosystem along the West Maui region as a priority management area. In April 2015, West Maui was designated as a Resilient Land and Waters Initiative site by the Department of the Interior, the Environmental Protection Agency and the National Oceanic and Atmospheric Administration. The Watershed Management Plan for Wahikuli and Honokōwai was completed in 2012 and the plan for Kahāna, Honokahua and Honolua Watersheds will be completed in 2016. http://www.westmauir2r.com/

d. Support stream restoration and increased use of *kalo* lands.

Stream restoration as both an objective and result of establishing numeric Instream Flow Standards, will increase and enhance opportunities for food production and cultural water uses. Although the authority and responsibility for assessing resources and establishing Instream Flow Standards lie with the State CWRM, input from the Native Hawaiian community indicate that grassroots efforts are ongoing and there is community interest to collaborate with state and county agencies. The roles and work efforts should be identified to propel assessment of stream resources and ensure restoration projects come to fruition.

e. Enable and assist in providing for Native Hawaiian water rights and cultural and traditional uses through active consultation and participation.

Native Hawaiian water rights are specifically protected in the State Constitution, Section 221 of the Hawaiian Homes Commission Act and the State Water Code, Section 174C-101, providing for the needs of Department of Hawaiian Home Lands; traditional and customary gathering rights; and appurtenant water rights of kuleana and kalo lands. Protecting Native Hawaiian rights must be accomplished through establishing instream flow standards. CWRM must balance in-stream uses, domestic uses, Native Hawaiian and traditional and customary uses with reasonable and beneficial off-stream uses. Active engagement between state and county agencies and the Native Hawaiian community is needed to ensure water rights are safeguarded and to inform public policy decision makers.

The Aha Moku System can serve to provide advice on integration of Native Hawaiian resource management practices with western practices in each moku and identify a comprehensive set

of Native Hawaiian practices for natural resource management. [24]In meeting with the water committee of Moku O Pi'ilani and members of Wailuku, Kula, Honua'ula and other mokus, support was voiced for initiating and implementing a consultation process for MDWS's water resource plans and management. The recently adopted Rules of Practice and Procedure for the DLNR 'Aha Moku Advisory Committee (AMAC) defines "Collaborative governance" as a "governing arrangement wherein one or more public agencies such as the department of land and natural resources and its divisions, directly engage non-state stakeholders, such as the 'aha moku advisory committee and island 'aha moku councils, in a collective decision-making process that is *formal*, *consensus-oriented*, and *deliberative* and that aims to make or implement public policy or manage public programs or assets. Collaboration implies two-way communication and influence between agencies and stakeholders. Although ultimate authority lies with the department, stakeholders directly participate in the decision-making process." The rules also sets forth the communication process in advising agencies for those participating in the 'aha moku system as well as a form for the island Po'o (representative) to use.

Maui DWS should collaborate with the established 'Aha Moku Advisory Committee and Moku O Pi'ilani and consult with designated AMAC representative(s) in developing and implementing public policy and managing public programs as it relates to regional resource development.

Water Quality Management

Groundwater Quality Issues

We are fortunate to be endowed with generally excellent ground and surface water quality throughout Maui. Groundwater can become contaminated from a range of land uses, including agricultural pest control, industrial activities, leaks and spills from chemical storage. Once chemicals infiltrate soil and reach the aquifer, contamination can linger for decades due to persistence. Pesticides applied decades ago remain in Maui aquifers and requires costly treatment where detections exceed acceptable levels. Microbial contamination at the source (which is different from pathogens that can occur within the distribution system) can result from cesspools, sewage sludge disposal, reclaimed water irrigation and other activities. Multiple studies have shown that protection at the source outweigh treatment costs. Remediating contaminated groundwater can be 40 times more expensive than taking steps to protect the source. For small community sources, this ratio can be as high as 200:1.[25] Water quality that not only meets, but exceeds federal and state drinking water standards protects public health and improves the community's confidence in municipal and private water utilities.

The Safe Drinking Water Act, amended in 1996, establishes primary drinking water standards, treatment technologies and monitoring schedules. The Act mandated a statewide Source Water Assessment of all public water systems to be completed by the SDWB. The assessment delineated areas where potential contaminating activities may impact the water source, inventoried potentially contaminating activities and ranked the susceptibility of ground and

[24] Leimana DaMate, Status Report on Aha Moku to the Commission on Water Resource Management in Regards to Water Use in the Kona District Moku O Keawe (Hawaii Island), May 19, 2016

[25] AWWA Manual M50 Water Resources Planning, 2001

surface water sources to contamination. The assessment laid the framework for protection measures on a local level. Drinking water regulations address existing contamination but does not prevent future contamination of drinking water sources. The State Wellhead Protection Program, established by the Safe Drinking Water Act, provides guidance to communities in developing protective measures on a local level. Proactive measures are needed to minimize threats to drinking water sources from current and future potential sources of contamination.

Emerging water quality issues are anticipated as new chemicals are introduced into water supply. Contaminants that are subject to potential regulation include those on the U.S. EPA's Contaminant Candidate List. As additional contaminants are assessed and analytical methods improve, new and more stringent drinking water regulations are expected.

Objectives

a. Protect and maintain the quality of water resources and delivery systems

General Plan Policies

a. Improve water quality and the monitoring of public and private water systems.
b. Protect and maintain water delivery systems.

Recommended Strategies

a. Implement well siting criteria to avoid contaminated groundwater supplies and unnecessary risks to public health.

Well development in areas with current or historic contaminating activities unnecessarily subjects the public to contaminants and often necessitates reliance on costly treatment. Policy and procedure for siting new wells should apply to wells developed by MDWS or wells to be dedicated to MDWS. Well siting criteria to avoid contaminated water supply should be considered to the extent feasible by all public water systems. This strategy implements the MIP action item to "develop, adopt, and implement water source development siting standards that implement the MIP Directed Growth Plan and the WUDP, and protect water quality for existing and future consumers."

b. Adopt wellhead protection measures for potable wells.

Establish protective measures and acceptable land uses within potable well capture zones. A wellhead protection strategy for MDWS wells was developed with significant public participation, resulting in a draft ordinance. The strategy and ordinance builds upon the State Source Water Assessment Program and established best management practices to prevent contamination from potentially contaminating land uses and restricts high risk activities in capture zones of MDWS wells. Adoption of the draft ordinance has strong support from the community, the State DOH, and state experts in the water resource and hydrology field. [26] This

[26] Testimony by State of Hawaii Department of Health, 1/13 2014 and 8/20 2015; Testimony by Dr. Donald Thomas, 10/15 2015; Testimony by Dr. Daniel Amato, 10/15 2015; Testimony by Dr. Nicole Lautze, 10/19 2015

strategy supports the WUDP objective of maximizing water quality and ensures consistency with the State Water Quality Plan prepared by the State Department of Health.

c. Support increased monitoring of groundwater sources and update assessment of potential contaminating activities around drinking water supply.

Source water monitoring schedules are established in primary drinking water standards. Sampling frequency varies by regulated contaminant and detections. Improved monitoring of existing wells that have history of contamination or that is ranked as highly susceptible to contamination in the State Source Water Assessment, reduces the risk to public health. The need and cost of increased sampling frequency should be weighed against history and type of contaminants on a case by case basis. Public water systems that have multiple contaminants detected in one source at concentrations close to, but below Maximum Contaminant Levels may benefit from additional sampling to identify spikes in concentrations and to determine whether and when treatment is warranted.

The 2007 Source Water Assessment of public water systems on Maui has not been updated to reflect new land use activities or new developed groundwater sources. Public water systems should take advantage of the technical assistance available from the SDWB and update assessment of activities in capture zones. As new groundwater sources are developed, capture zones should be delineated and potential contaminating activities assessed. Inventoried data related to activities that are deemed to pose a risk to groundwater supply should be made available to public water system customers.

Surface Water Quality Issues

Streams are subject to sediment build up, erosion, nutrients and turbidity that can impact in stream uses and require additional treatment for off stream uses. The State Department of Health Clean Water Branch monitors activities and report on impairments of waters, including Total Maximum Daily Loads (TMDL). The 2012 Integrated Report on impaired inland waters, found that the most common occurrences of pollutants not meeting state water quality criteria were turbidity, followed by Nitrate+Nitrite Nitrogen.[27] TMDL priority, low to high, was assigned for initiating TMDL development. Four Maui streams were assessed as "Medium" TMDL Priority: Honokowai Stream, Iao Stream/Wailuku River, Kahana Stream, and Kahoma Stream. No Maui streams were assigned categories representing "impaired" waters. No other pollutants were identified in Maui streams, except for "trash" in Wailuku River and Ohia Stream. The updated 2014 assessment did not address any Maui inland freshwater bodies.

Maui agriculture is heavily dependent on surface water as irrigation supply. This use comes with a responsibility to protect streams from agricultural pollutants and practices. Agriculture is the nations' leading source of pollution for ground, surface and coastal waters. [28] Livestock and crop farming practices can contribute sediments, nutrients from fertilizers and animal waste, agricultural chemicals and bacteria from animal waste. Sediment and pollutants in raw

[27] 2012 State of Hawaii Water Quality Monitoring and Assessment Report

[28] https://archive.epa.gov/region9/strategicplan/web/html/index.html

water increases needs and costs of surface water treatment. Sediment buildup in reservoirs can decrease storage volume and delivery efficiency.

The primary water quality challenges using surface water for potable supply include mitigating disinfection byproducts and lead and copper levels in public water supply. Organic matter in raw water when combined with chlorine form disinfection byproducts, some of which pose public health risks. Permitted levels are regulated under the Stage 1 Disinfectant/ Disinfection Byproducts Rule (D/DBPR) and Stage 2 D/DBPR, established under the Safe Drinking Water Act. The chemistry of certain surface water supply is corrosive which can cause lead and copper in older household plumbing to leach into drinking water at the tap. The Lead and Copper Rule (LCR) promulgated by the U.S. EPA sets action levels, that if exceeded requires corrosion control measures and other mitigating actions. MDWS is in full compliance with D/DBPR and LCR and continuously assesses treatment technologies to maintain and improve drinking water supply quality. However, emerging disinfection byproducts are being discovered and future additional regulations of those disinfection byproducts that pose a risk to human health can be anticipated.

Objectives

a. Improve water quality and the monitoring of public and private water systems.

General Plan Policies

a. Protect and maintain water delivery systems.

Recommended Strategies

a. Educate the farming community in sustainable farming practices to reduce impact from agricultural practices on water resources.

Sustainable farming practices include development of a conservation plan to address runoff; waste management to prevent animal wastes to contaminate water supply; fertilizer, and pesticides and herbicides management to mitigate over application and to ensure proper storage and disposal. [29] Workshops and education outreach are sponsored by MDWS, Hawai'i Rural Water Association and DOH. Continued outreach should encourage farmers to take advantage of existing programs and technical assistance through the Soil and Water Conservation Districts, the State Department of Agriculture and DOH.

b. Support and fund capital and process improvements and monitoring of surface water systems to ensure compliance with drinking water standards.

Water quality challenges related to corrosion and water chemistry have primarily been limited to the MDWS Upcountry system. Except for MDWS, no other public water systems rely on surface water as potable supply. Process improvements and monitoring for the Upcountry system is addressed under Section 15.8.

[29] http://health.hawaii.gov/cwb/site-map/clean-water-branch-home-page/polluted-runoff-control-program/prc-hawaiis-implementation-plan/agriculture/

12.2 CONSERVATION

The protection of water resources and the wise and sensitive use of water resources can be advanced though a robust water conservation program that reduces consumption of water, reduces water loss and increases efficiency of water systems and use. Conserving water and avoiding water loss is important for long-term sustainability and benefits the community, environment and water suppliers even in times of abundant rainfall. Reductions in water use though conservation and improved efficiency broadly decrease impacts on ecological systems, and on cultural practices that depend upon these systems. Reducing existing and future demands on water resources can delay the need to develop new sources of water, delay or avoid additional capital infrastructure, decrease operating costs, reduce energy use, and decrease environmental degradation and water use conflicts.

Conservation can be characterized as **demand side strategies** that generally promote reduction in water use, and **supply side strategies** that focus on water system efficiency and loss control from source to end use. Demand-side management options are usually programs undertaken by a water utility to encourage the use of efficient fixtures and appliances or practices by its customers, or to encourage customers to shift their time of use. Such programs often provide for direct installation or incentives such as rebates to encourage purchase of efficient fixtures or appliances. Other components focus on regulatory controls and educational programs to instill a conservation mindset and support other programs. Supply side measures include water audit/non-revenue water analysis, leak detection and meter maintenance and replacement.
Conservation programs can be implemented by water purveyors of all sizes. While this section of the WUDP focuses on conservation of ground and surface water sources, measures can also be applied to alternative water resources to improve efficiency and reduce costs.

Conservation Issues and Opportunities for Non Agricultural Uses

Maui has historically had the highest water consumption of all the Hawaiian Islands primarily due to streamflow diverted for plantation irrigation. While the diversion and transport of water for agriculture has already decreased with the curtailment of HC&S operations, demands for new agricultural pursuits, population increase and new development will continue to put pressure on Maui's water resources. Issues and opportunities specifically related to agricultural irrigation is discussed under Section 12.2.5 below. In developing the WUPD, a broad range of concerns were expressed through the community outreach process:

- Satisfaction of kuleana and public trust uses, and the balancing of public trust and other beneficial uses such as agriculture when conflicts occur.
- The effect of water diversion and transport on kuleana and public trust uses and local ecosystems.
- Protection of freshwater quantity and quality.

- Water resource sustainability during drought and with changing climate conditions.
- Promote a culture of living within our means, with design and use more commensurate with the water resources of the local area, particularly for landscape, resort and agricultural needs.
- Align the level of water with the type of use. Maximize use of alternative water resources, such as recycled, greywater, catchment and stormwater.
- Increase surface water system and use efficiency, and decrease water loss.
- Increase capacity and reliability of water systems to meet challenges in a cost-efficient manner.
- Use a varied regulatory, incentive, educational and rate-based approach, addressing all existing and future use types.
- Create a community conservation mindset through education and government leading by example.

The development and implementation of water conservation strategies and programs should carefully consider these issues. Reducing consumption particularly for landscape uses in dry areas is of particular interest to community members. In general, an effective water conservation and loss control program can reduce the demand on freshwater resources through reduced consumption, offsetting use with alternative resources, and reducing loss of water and leaks during conveyance and by the end user. A robust conservation and efficiency program will help address surface water diversion and water transport issues and support protection of kuleana and public trust uses. A conservation program of specific actions can entrust citizens as well as entities with responsibility and accountability for efficient water use thereby building a culture of water management responsibility. The program should consider how regional differences in water resources and uses can be engaged through conservation efforts. The WUDP Planning Objectives are all directly or indirectly relevant to water conservation as discussed in connection with proposed strategies and measures.

State Planning

The *State Water Code's* directive to "protect, control, and regulate the use of Hawai'i's water resources for the benefit of its People" authorized the CWRM to protect and enhance the water resources of the state of Hawai'i through wise and responsible management.

The *Hawai`i Water Plan, Water Resource Protection Plan* addresses the conservation of water resources. In carrying out its responsibilities, such as establishment of protection of aquifer and instream flow standards and issuance of water use permits, the CWRM has evaluated efficiency and loss of water conveyed by delivery systems from source to end uses, and as relevant applied conditions to address those concerns. Conservation supports the *Water Quality Plan* by reducing pressures on freshwater resources, which may otherwise exacerbate salinity and other water quality issues.

The *Hawaiian Homes Commission Water Plan Policy* calls for water stewardship in a manner that balances cost, efficiency measures and Public Trust uses in the short and long term.

The *Hawaii 2050 Sustainability Plan* states that per capita water consumption reflecting conservation and renewable energy use are leading indicators of a 'sustainability ethic', which is a priority action of the *Plan.*

The Hawai`i Fresh Water Initiative's report, *A Blueprint for Action-Water Security for an Uncertain Future*, calls for improving the efficiency of the total underground aquifer water use rate by eight percent from 330 gpd per person (statewide average) to 305 gpd per person, in order to increase water availability by 40 mgd by 2030. The key strategies are to reduce potable water use on landscape areas, encourage audits and leak detection which also increase water security, and improve agricultural water efficiency.

The purpose of the *Hawai`i Water Conservation Plan* (2013) is to identify and implement water use and delivery efficiency measures to conserve the fresh water resources of the state. The plan focuses on demand side conservation and is intended to be a guiding document for the CWRM as it develops and implements water conservation measures that can be implemented across the state by public water suppliers, agricultural, and other water users.

The *Hawai`i Drought Plan, 2017 Update* states that an aggressive water conservation program is an essential component of drought mitigation. Water conservation should be promoted statewide and practiced within all water use sectors. A recommended priority action is to support water conservation, reuse, and recharge measures as part of increasing freshwater security.

The *Hawai'i Climate Change Adaptation Priority Guidelines* states that water conservation is a critical component of climate adaptation and can increase resilience to declining water supply or more frequent or longer droughts. The Priority Guidelines Tools focus on avoiding over-allocation of groundwater, such as demand-side conservation, mandatory water conservation and recycling plans, and incorporating water conserving design and use efficiency into new development and redevelopment supported by incentives.

Goals, Objectives and General Plan Policies

The Goals, Objectives and Policies established in the County's *General Plan 2030* and *Maui Island Plan* relating to water conservation are water shown in the table below. General guidance provided in the Community Plans is reflected in the MIP.

Table 12-1 Maui Island Plan and General Plan Goals, Objectives and Policies Related to Conservation

County Planning Policy/Measures	Plan
Goal: Restore watersheds and aquifer-recharge areas to healthy and productive status, and increase public knowledge about the importance of watershed	GP

stewardship, water conservation, and groundwater protection.	
Objective 6.3.2 - Increase the efficiency and capacity of the water systems.	MIP
Policy 6.3.2.a - Ensure the efficiency of all water system elements including well and stream intakes, water catchment, transmission lines, reservoirs, and all other system infrastructure.	MIP
Policy 6.3.2.e - Ensure water conservation through education, incentives, and regulations.	MIP,CP
Action 1 - Develop programs to increase the efficiency of all water system elements.	MIP
Action 3 - Revise County regulations to require high-efficiency, low-flow plumbing fixtures in all new construction.	MIP
Action 6 - Develop a water rate structure that encourages conservation and discourages the excessive use of water.	MIP
Provide incentives for water conservation practices.	MIP,CP
Action 7 - Develop a comprehensive water conservation ordinance to include xeriscaping regulations to promote water conservation.	MIP
Incorporate drought-tolerant plant species and xeriscaping in future landscape planting.	CP
Encourage use of non-potable water for irrigation purposes and water features. Kihei-Makena: Prohibit use of potable water in large water features or require substantial mitigation fees.	CP

Abbreviations: GP- General Plan 2030, MIP- Maui Island Plan, CP-Community Plan.

Maui County has adopted the following regulations that support water conservation generally:

- Maximum flow rate standards for plumbing fixtures sold by local distributors (Maui County Code, Chapter 16.20B)
- Plumbing code regulations that require low flow fixtures in new development (Maui County Code, Chapter 16.20B).
- Education and incentives. MDWS shall promote water conservation education; as reasonable provide water-efficient faucet, shower fixtures, and outdoor hose nozzles to consumers upon request at no charge; and implement an incentive program to encourage consumers to replace old toilets and water fixtures with water-efficient fixtures. (Maui County Code, Chapter 14.06A)
- Leak detection. MDWS to monitor water consumption and issue high-consumption notices to consumers when warranted, prioritize the replacement of old and leak-prone water mains, as reasonable distribute toilet tank leak detection tablets or other methods to consumer upon request, and encourage the public to report water leaks. (Maui County Code, Chapter 14.06A)
- MDWS may discontinue water service where negligent or wasteful use of water exists on any premises. (MDWS Rules and Regulations, Section 3-10)
- Control of water usage during a drought. MDWS "may declare a water shortage whenever the water supply becomes inadequate in any area in the County or County water system

because of a period of drought, an infrastructure or mechanical malfunction, natural disaster, or other event causing a water shortage." The director may prohibit water usage during certain hours or days of the week; prohibit the use of water for irrigation, lawns, personal washing of vehicles, construction, subdivision, or other types of activity involving the use of water; and institute water shortage water rates. (Maui County Code, Chapter 14.06A, MDWS Rules and Regulations, Section 4-1)

- Grey water systems: The Department of Environmental Management may permit irrigation methods that discharge gray water in a manner that ensures that the gray water does not surface. In addition to specified irrigation systems, collection and distribution systems such as laundry-only gray water systems may be approved. (Maui County Code, Chapter 16.20B)
- New golf courses shall not use any amount of potable water for irrigation and other nondomestic uses (other than drinking, bathing, heating, cooking, and sanitation). (Maui County Code, Chapter 14.08)
- Recycled water. Improved commercial property must connect to an available recycled water distribution main within 100 feet of the property line within one year of service availability for an existing irrigation system, or at the time a new irrigation system is constructed.[30] (Maui County Code, Chapter 20.30)

Conservation Related to Population Based Demand

Conservation associated with population based demand, excluding large agricultural and irrigation uses, is addressed in this section. This demand is largely comprised of potable water served by public water systems, with about 90 percent supplied by MDWS on Maui Island. Average per capita use dividing total water consumption by population was similar for MDWS (264 gpd) and private public systems (254 gpd) in 2014. Existing water consumption figures incorporate conservation measures that are currently in use, and it is assumed the savings produced by those measures will continue to be embedded in future consumption rates.

<u>Potable Demand – Residential Uses</u>

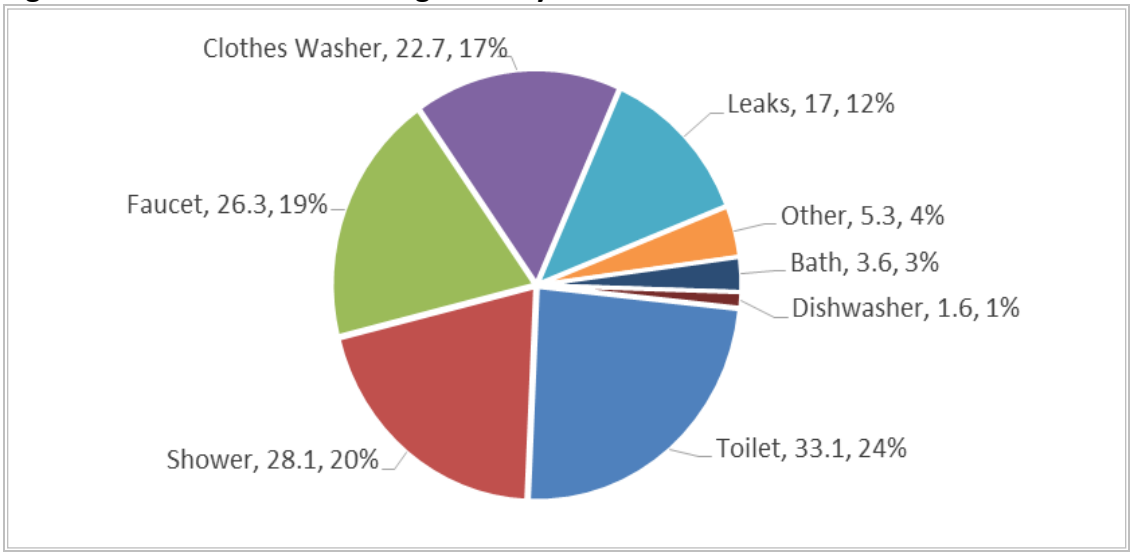
Residential uses comprise the largest consumer for most public water systems; residential uses consumed about 64 percent of water supplied by MDWS in 2014. Significant factors influencing indoor use include number of people per dwelling, housing type, fixture efficiency, water use behavior, and water rates. Number of people per household is strongly correlated with indoor water use per dwelling. Household use rates are about 10 percent lower than per capita rates due to efficiencies of scale, and multi-family units use about 10 percent less water than single-family units due to fewer dishwashers, clothing washers and leaks. Per capita indoor water use should not significantly vary by region and therefore region specific indoor conservation programs are not indicated.

[30] Improved commercial property also includes golf courses, landscaping and agricultural uses, except properties used for single-family or duplex purposes. The Code refers to reclaimed water; for consistency throughout this document the term recycled water is used.

Indoor water use rates derived from various sources range from about 120 to 140 gallons per household per day (gphd). The 16-year study, *Insights into declining single-family residential water demands (2012*) states that agencies should be planning for per capita demands of around 40 gpcd or less for a family of three, and household use of 120 gphd. An adjusted average water-efficient household rate for Maui Island equates to about 150 gphd for single-family units and 135 gphd for multi-family units.[31] The 2002 Water System Standard of 600 and 540 gallons per unit for single- and multi-family units respectively includes accessory outdoor uses. There are few recent empirical examples of restricted indoor water use per unit or lot, with a separate system supplying non-potable needs; Wailuku Country Estates exhibited an average of 255 gpd per lot of potable water in 2014, with the higher demand likely attributed to lots with accessory units. Residential uses served by MDWS had an average per capita rate of 156 gpd in 2014; for purposes of analysis indoor use was estimated at 70 gpd per capita with the remainder attributed to outdoor use.

Water use rates have changed over time with the greatest savings from toilets and clothes washers. *The Residential End Uses of Water (REU2016)* found average indoor water use among utility customers studied was 138 gphd compared to 177 gphd in the 1999REU study.[32] The figure below compares use by fixture for single-family homes in the *REU2016* study. Toilet flushing was the largest indoor use, followed by showers, kitchen and bathroom faucets, clothes washers, and leaks in the *REU2016*.

Figure 12-5 National Indoor Single Family Household Water Use



The Residential End Uses of Water (2016)

[31] 138 gpcd is 89 percent of a per-capita-based household rate for Maui Island based on 2015 household water use.

[32] The participating utilities in the 1999 and 2016 Residential End Uses of Water studies differed. In the 1999REU most were in the west and southwest US, while they were more distributed throughout the US in the 2016REU. The 2016 study used 2010-2013 data.

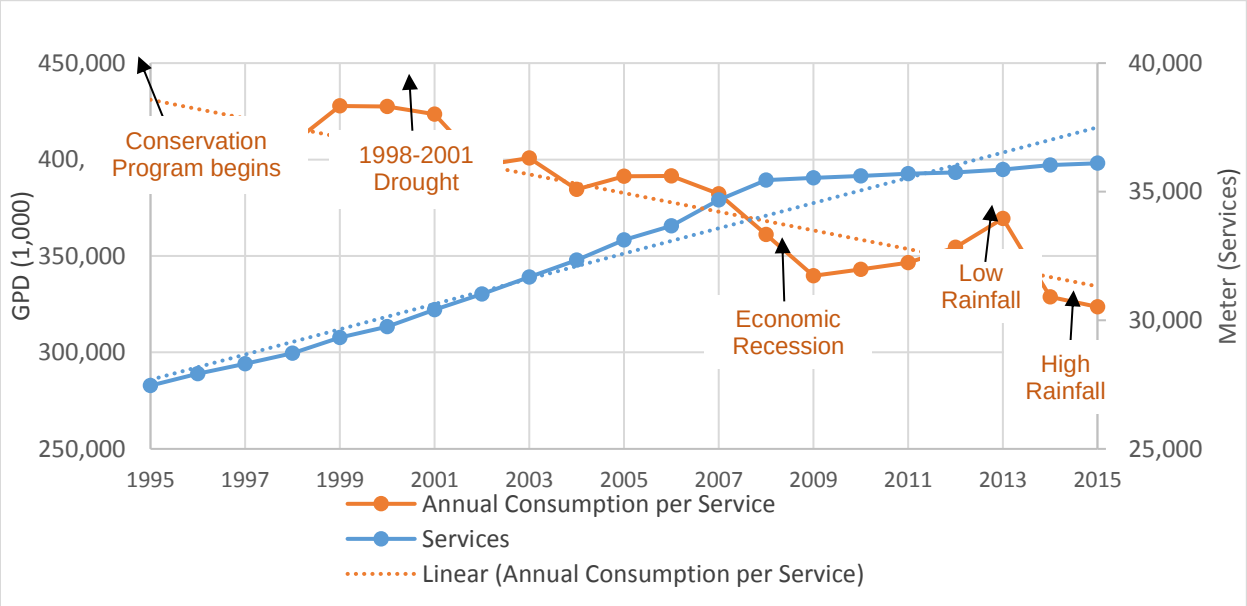
Water demand per service has been decreasing as a result of water efficiency regulations supporting water efficient products and development and supporting programs. Maui County Code, Chapter 16.20, effective December 31, 1992, which affects all development in Maui County regardless of purveyor, established a maximum rate of water flow or discharge for plumbing fixtures and devices in order to promote water conservation. MDWS also launched its water conservation program in the mid-1990s by providing low flow devices and toilet leak detection tablets to its customers.

Table 12-2 Fixture Flow Rates

Devices	Maui County Code, 1993 and Later	MDWS Customer Giveaway Program
Kitchen faucets	2.2 gpm	1.5 gpm aerators
Bathroom faucet	2.2 gpm	1.0-1.5 gpm aerators
Showerheads	2.5 gpm	1.25-1.5 gpm
Toilets	1.6 gpf	0.8 gpf savings
Urinals	1.0 gpm	n/a
Hose nozzles	3.0 gpm	2.4 gpm maximum

Tiered water rates and other programs such as community education are also contributing factors that may be beneficial. From 1995 to 2015 the number of MDWS services (meters) increased over 30 percent while demand increased by about two percent, for an average decline of 22 percent per meter.[33]

Figure 12-6 Maui Department of Water Supply Consumption Compared to Services, 1995-2015



MDWS, includes all services for Maui County including agricultural services.

[33] Includes all MDWS systems serving Maui County; includes agricultural services. Decline was on average about 1100 to 900 gpd per service.

A considerable amount of water could be saved by retrofitting older dwellings and using water-efficient appliances. The *2016REU* study found only 37 percent of residences met an efficiency level of less than 2.0 gal. per flush and 46 percent had clothes washer with less than 30 gal. per load, while 80 percent exhibited less than 2.5 gal. per minute for showers. While new residential units are required to conform to plumbing codes, adopting more restrictive codes than required by state law can further increase water savings in future development and retrofits. Since age of housing stock and remodeling and useful life of fixtures and appliances affect water conservation and efficiency, a robust water conservation program can increase adoption of more water-efficient devices, fixtures, appliances and behaviors.[34]

In the *2016REU* study, about 50 percent of water use was assumed to be attributed to outdoor uses such as landscape irrigation, water used through hose bibs, swimming pool related, washing pavement and cars, etc.[35] MDWS in 2016 and 2017 surveyed people about watering their yards at several events and other places where high-efficiency water fixtures were given out; of 802 responses 60 percent prefer hand watering, 27 percent use sprinklers, 12 percent use drip irrigation systems, and 2 percent use other methods such as rainwater catchment, greywater from washing machines, and natural springs.[36]

Water savings of 20 percent or more can be estimated using mild to aggressive landscape water conservation programs. Pricing programs, water-conserving landscape, and reduction in planting areas may achieve outdoor demand reductions beyond efficiency measures.[37] The effect of a hypothetical 20 percent reduction in residential sector outdoor use is shown in Figure 12-7.

Potable Demand – Nonresidential Uses

The major end uses associated with commercial and institutional facilities include domestic and restroom uses, kitchen, heating and cooling, and landscaping according to *WaterSense at Work* (EPA, 2009). Commercial and government use comprises about 30 percent of MDWS consumption. Water-efficient products can deliver increased savings; for example, WaterSense labeled products are certified to use at least 20 percent less water than standard models. While water use fixtures for office and retail uses are similar to residential uses, programs targeted to locally prominent uses, such as hotels and restaurants, can be effective. Outdoor water for a variety of purposes can account for five to 30 percent of a facility's total water use. Proper landscape design, landscape systems, and regionally appropriate plant choices and pool practices can significantly reduce water use:

- Drip irrigation on plant beds instead of traditional sprinklers: 20-50%
- More efficient sprinkler heads: 30%
- Smart irrigation controllers: 15%

[34] *The Residential End Uses of Water, Executive Report, Version 2, 2016*.
[35] *The Residential End Uses of Water, Executive Report, Version 2, 2016*.
[36] MDWS High Efficiency Fixtures Distribution Results, FY 2017.
[37] *The Residential End Uses of Water, Executive Report, Version 2, 2016*.

- Pool covers: 30-50% of evaporation [38]

Conservation Targets

Population based demand projections incorporate past conservation but do not take into account future conservation potential. The 2035 projected demand for all public water systems of 55 mgd could be theoretically reduced to 46 mgd based on an 8 percent reduction in per capita demand as shown in the figure and table below.[39] Reduction in MDWS residential demand based on both (1) a theoretical water-efficient target for indoor and outdoor use, in addition to an 8 percent per capita decrease, indicates the potential to offset most of the new residential demand during the planning period to 2035 through installation of water-efficient fixtures in new development; retrofit of existing development proactively, as fixtures wear out, or units are remodeled or replaced; and through water-efficient outdoor controls and practices. The conservation target for residential use is based on (1) an estimated 2015 indoor use of 70 gpd per capita, reduction of the 2015 rate to 40 gpd by 20 percent per 5-year increment resulting in 80 percent retrofit by 2035, and new population demand of 40 gpd per capita from 2015 to 2035, resulting in an combined average of 45 gpd per capita by 2035; and (2) a 20 percent reduction in outdoor demand.[40]

[38] US EPA, WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities, October 2012.

[39] Public water systems include community public water systems that supply water to the same population year-round. https://www.epa.gov/dwreginfo/information-about-public-water-systems

[40] California Urban Water Conservation Council BMP to retrofit 75% of residential housing constructed before 1992 with water-efficient devices, Table 2-3, p. 28. AWWA Water Conservation Programs—A Planning Manual M52, 2006.

Figure 12-7 Water Conserved, 8% Per Capita Reduction and Water-Efficient Uses (mgd)

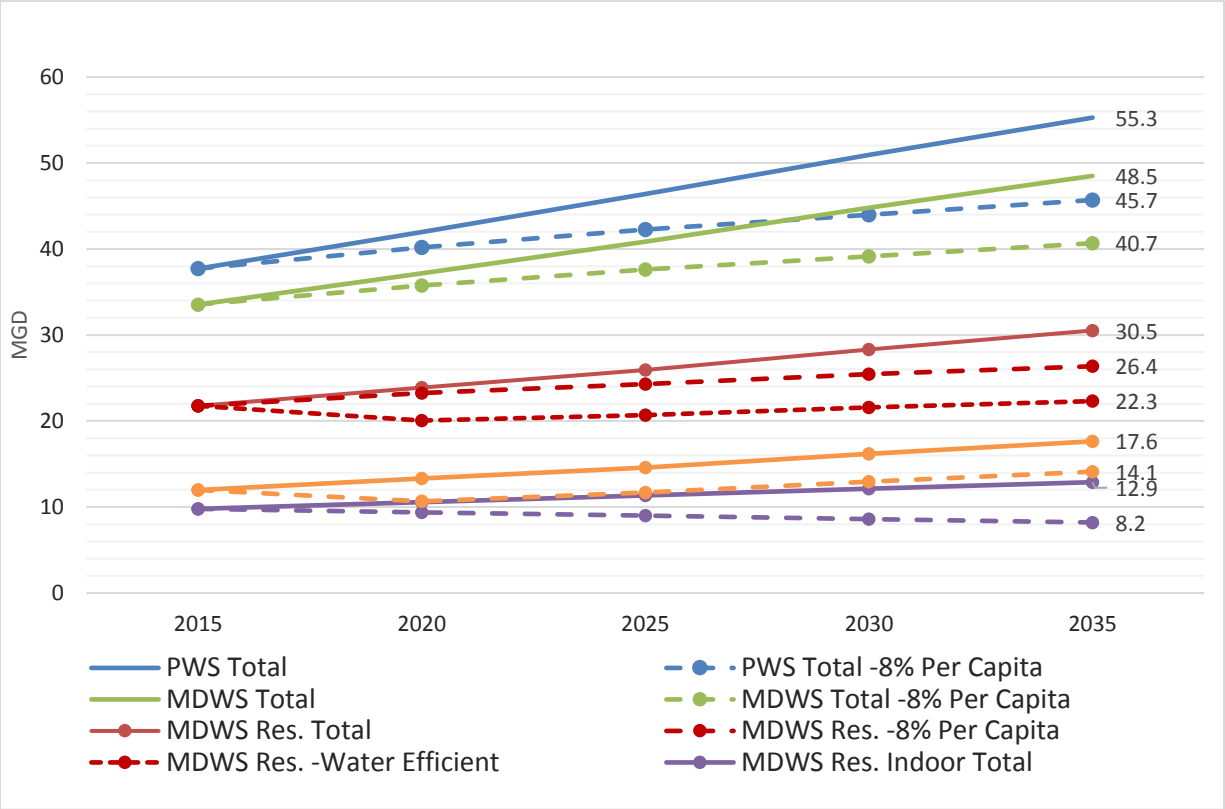


Table 12-3 Water Conserved, 8% Per Capita Reduction and Water-Efficient Uses (mgd)

Criteria		2015	2020	2025	2030	2035
PWS (All, includes MDWS)						
Maui Island Population		157,087	169,539	182,135	194,630	206,884
Per Capita Target (-8% by 2035) Gal/Day		240	237	232	226	221
Demand Base	**MGD**	37.72	41.96	46.38	50.95	55.27
Demand Target, -8% Per Capita	**MGD**	n/a	40.18	42.26	43.99	45.70
MDWS						
Maui Island Population Served		139,807	150,890	162,100	173,221	184,127
Per Capita Target (-8% by 2035) Gal/Day		240	237	232	226	221
Demand Base	**MGD**	33.54	37.16	40.85	44.80	48.50
Demand Target, -8% Per Capita	**MGD**	n/a	35.76	37.61	39.15	40.67
MDWS RESIDENTIAL						
Demand Residential Base	**MGD**	21.76	23.89	25.94	28.33	30.53
Per Capita Target (-8%)	***Gal/Day***	156	154	150	147	143
Demand Target, -8% Per Capita	**MGD**	n/a	23.24	24.32	25.46	26.37
Water-Efficient Use Target (Per Capita gpd)	***MGD***	n/a	20.06	20.67	21.57	22.32
Indoor Demand Base, 70 gpd Per Capita	**MGD**	9.79	10.56	11.35	12.13	12.89
Indoor Demand Target, 40 gpd Per Capita	**MGD**	n/a	9.39	9.00	8.61	8.20
Outdoor Demand Base	**MGD**	11.98	13.33	14.59	16.20	17.64

Criteria	2015	2020	2025	2030	2035
Outdoor Demand Target, 20% Reduction **MGD**	n/a	10.66	11.67	12.96	14.11

MDWS, Water Resources & Planning Division, 2017. Maui Island demand.
PWS (public water system) demand: population demand, excluding large agricultural demand and irrigation wells. MDWS population served calculated as 89% of Maui Island population. MDWS Residential, Assumptions: Indoor Demand-population per 5-year increment@70 gpd. Remaining demand is Outdoor Demand. Indoor-Efficient Codes- 2015 population@70 gpd; 2020-2035- increased population@40 gpd + 2015 demand (20% of 2015 demand reduced each 5-year increment to 40 gpd – fixture life, remodel, unit replacement. About 80% of Maui County housing units are assumed to have less water-efficient fixtures based on housing stock age).
Outdoor-Efficient- 20% reduction.

Conservation Strategies

Water use conservation through improved efficiency and regionally climate adapted irrigation, coupled with increased use of alternative resources to offset potable supply, can significantly and cost-effectively reduce freshwater water and increase resource sustainability.

Public input at more than 20 community, target group and policy board meetings in 2015 and 2016, and via several surveys administered by MDWS show support for a variety of approaches to increase conservation as indicated below. There was much less agreement with behavioral controls, such as restrictions on time of day or days per week for watering residential landscaping.

Community members said …

- *Exercise control over water use and efficiency at the design phase rather than using behavioral controls*
- *Increasing water cost is the only effective way to produce conservation*
- *We have been talking to our kids about trade-offs - coaching them on how they shower and brush their teeth, that we can catch rain water to nourish the garden and fill the pool*

Survey of Potential Water Conservation Strategies and Measures - Over 75% Agreement

- ✓ Existing and new development equally bear responsibility for water conservation
- ✓ More aggressive conservation in new development in all areas
- ✓ More aggressive conservation in dry than wet areas (esp. large commercial landscaping)
- ✓ Adopt a restrictive water conservation standard for new development
- ✓ Require low-flow fixtures and water-conserving landscape in new development
- ✓ Implement a program to retrofit toilets in existing development
- ✓ Require all new landscape irrigation systems to be water-efficient
- ✓ Require existing large commercial users to reduce landscape water use
- ✓ Increase water conserving landscape requirements for resorts, golf courses, public facilities
- ✓ Maximize recycled wastewater use for irrigation uses
- ✓ Adopt grey water system programs for small residential and commercial irrigation
- ✓ Provide incentives for residential and small commercial catchment systems

The cost-effectiveness of conservation strategies is an important consideration in developing and sustaining a conservation program. Cost-effectiveness compares the costs of a portfolio of programs to promote water savings with the costs the utility and its customers would otherwise incur. In evaluating cost-effectiveness, MDWS compared the costs to develop and deliver new sources of water to meet future demand with the savings attributed to conservation. Cost savings, which vary with the portfolio of conservation programs selected, market penetration, timeframe and other assumptions, could be demonstrated for both basic and aggressive programs assisted by the economies of scale MDWS enjoys as the largest purveyor. For example, a five-year conservation program for the MDWS Central District with 45 percent penetration at an expenditure of $5M would reduce costs by $9.4M,[41] and a 10-year program with 45 percent penetration at an expenditure of $3.6M would reduce costs by $4.0M.[42] In both cases, operating cost reductions exceeded capital cost reductions. The potential for a net savings is also expected for the West Maui/Lahaina MDWS system due to the need for new source development.

There are several issues associated with a conservation program. Mandatory codes and regulations (e.g., requiring installation of fixtures that are more efficient than existing standards or that restrict some types of water use) are generally more effective and less expensive to implement than incentive programs, but in order to be effective some enforcement measures may be required. "Policing" conservation measures is resource intensive and not supported by the community. Lastly, while programs may reduce customer bills due to less consumption, rates are not likely to be reduced due to fixed utility costs.[43] While it is beyond the scope of this WUDP to provide a programmatic plan for each public water system, the WUDP provides a framework for programs that can be evaluated and implemented to sustainably and cost-effectively manage the county's water resources.

MDWS Conservation Program

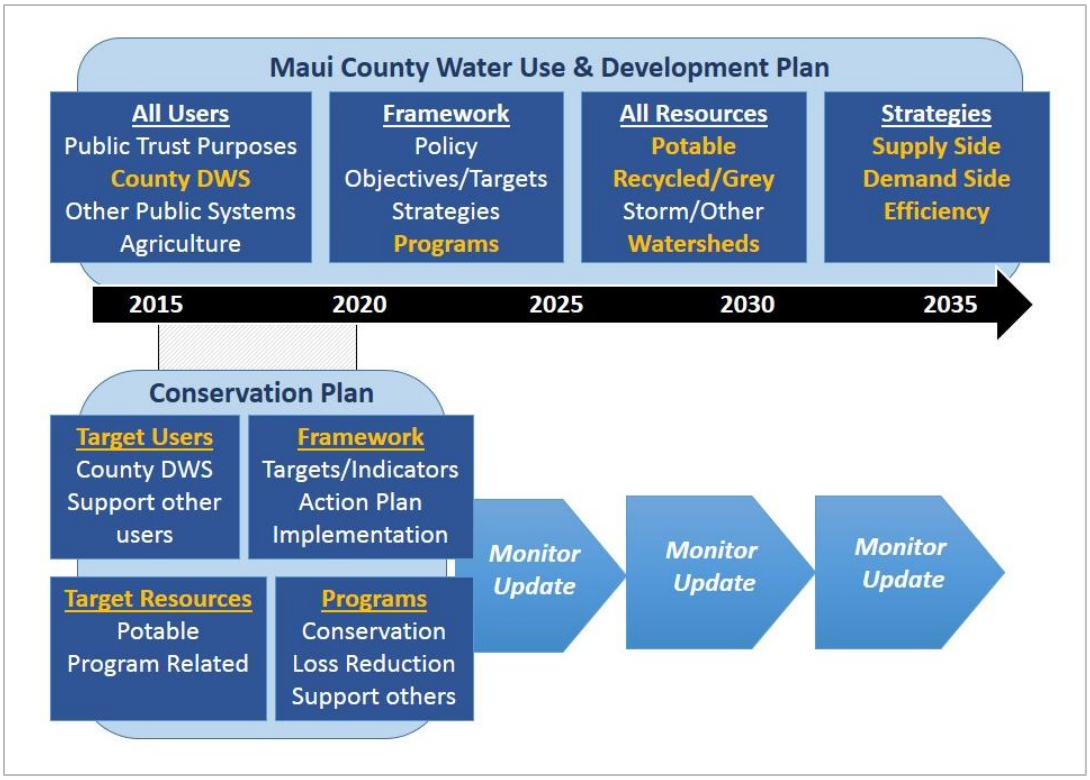
MDWS is preparing a Water Conservation Plan modeled after the *Hawai`i Water Conservation Plan*. While the WUDP provides long-term guidance and programs for all water uses and users of Maui, the water conservation plan focuses on specific short-term measures administered by MDWS within a longer-term framework as shown in the figure below.

[41] Freedman, Carl, Haiku Design and Analysis. Maui County Water Use and Development Plan, Central DWS District Update, Nov. 16, 2010, p. 21.; $4.2M/5.2M capital/operating cost reduction.

[42] Freedman, Carl, Haiku Design and Analysis. Maui County Water Use and Development Plan, Upcountry Final Candidate Strategies WAC Draft, July 27, 2009, p. 18; $1.5M/$2.5M capital/operating cost reduction)

[43] Freedman, Carl, Haiku Design and Analysis. Maui County Water Use and Development Plan, Central DWS District Update, Nov. 16, 2010, p. 22.

Figure 12-8 Conservation Plan Relationships



The water conservation plan will implement County policy, protect water supplies, and reduce water use by reducing waste and increasing efficiency, allowing MDWS to meet existing and future demand in a more efficient, economic and sustainable manner. The plan will provide programs and measures to reduce consumption by MDWS customers and target groups, as well as promote water conservation measures that can be used by the community at large. The water conservation plan will accomplish a measurable and significant reduction over time resulting in:

- Reduced average daily water demands
- Lower peak season water use
- Deferment of new water source development

The plan will help to substantially reduce water consumption and raise conservation awareness through best management practices (BMPs) and incentives that foster participation and self-initiative by Maui communities and businesses. Some of the considerations in evaluating and ranking BMPs include:

- Cost-effectiveness
- Technology/market maturity
- Service area match
- Customer acceptance/equity
- Is there a better measure available?

- Strength, Weaknesses, Opportunities, and Threats (SWOT) analysis. Some of the considerations include:
    - Contribution of existing water conservation projects and programs
    - Political support, public acceptance, equity, regulatory issues
    - Development and operational costs
    - Funding sources, revenue replacement
    - Ongoing and future infrastructure investment priorities
    - Coordination, partnership, cost-share opportunities
    - Data and technical resources
    - Reduced operating costs

MDWS's long-term planning efforts have considered implementation of extensive water conservation measures as a strategy to meet future needs. Some water conservation measures (e.g., fixture replacement, leak repair) will result in tangible source water savings that can be reliably allocated to new users, while other types of measures rely on customer behavioral changes that may not be lasting. Behavioral savings are not treated as equivalent to new source until the water agency is comfortable that the resulting savings are permanent. By helping to extend the life of existing facilities and postponing new source development and capital improvement projects, water conservation has a high benefit-cost ratio.

MDWS Conservation Program Costs

Water conservation programs are expressed as a percentage of the "technical potential" for savings by implementing water conservation measures and practices. The Maui County WUDP Central DWS District Update (2010) and Upcountry District Final Candidate Strategies Report Draft (2009) evaluated the cost-effectiveness of various conservation program portfolios. Life cycle costs were estimated by Haiku Design & Analysis for 10 to 15 years of conservation measure life. All candidate measures, with the exception for greywater pilot program, targeted by MDWS have current life cycle costs of $3 per 1000 gallons and below. [44] Evaluating attainment of alternative levels of technical potential (30%, 45%, 60% and 75%) within various timeframes (7, 10, 12, 15 years) under certain assumptions indicated that achievement of 45 percent of the technical potential would yield the best economic returns. Depending upon the circumstances and needs of each water system, the duration and intensity of program implementation may be more cost effective, but only to a point of diminishing returns. A domestic base indoor program portfolio, including direct retrofit of *all* toilets, showerheads and sink faucet restrictors to current code standards, and 35 percent reduction of outdoor irrigation use would cost-effectively attain 15 percent of the technical potential after five years of implementation, as well as over longer timeframes. The recommended portfolio of demand-side conservation measures are all incorporated into the WUDP:[45] Costs and potential savings

[44] Haiku Design & Analysis Maui County Water Use and Development Plan Resource Options Draft, May 15, 2007. (Life cycle costs adjusted to 2016 assuming a 3 % inflation rate)

[45] Maui County WUDP Central DWS District Update (November 16, 2010) and Upcountry District Final Candidate Strategies Report (July 27, 2009 Upcountry Water Advisory Committee Review Draft), Appendix A – Analysis of

of the MDWS portfolio are further analyzed in development of the department's Conservation Plan.

MDWS Demand Side Conservation Strategies

MDWS' comprehensive program that includes ongoing demand-side elements and expansions as recommended in the WUDP are summarized in the table below.

Table 12-4 MDWS Demand Side Conservation Strategies and Programs

Existing Use and Facility Audits and Retrofits	Distribution of water-efficient fixtures and retrofit/direct installation programs. Targeted audits and public facility water-efficient devices, fixtures and appliances programs
Agricultural Programs	• Irrigation efficiency – technical assistance and rebates. Audits of irrigation system equipment and practices and recommendations to customer to improve efficiency. • Agricultural working group workshops – knowledge sharing about irrigation issues and solutions
Public Information and Education	• Establish a sustainability working group to teach and educate stakeholders about the interdependence of the social, environmental, economic and technological dimensions • Develop technology/innovation transfer programs with universities and schools. • Create a water conservation recognition program to reward entities, organizations, and individuals who innovate ways and means to increase water conservation. • Invigorate effective, fun, and engaging public events and contests to educate our youth and all those institutions, families, friends, and businesses who participate • Participate in recognized conservation programs which provide ideas, templates, materials and support for conservation programs, such as WaterSense, a US EPA partnership program. MDWS is a member. • Public advertising and community events • Agricultural users group • Building Manager User Group and Services • Permit review targeted recommendations
Landscaping	• Landscaping guidelines • Landscape ordinance under development • Landscape audit and retrofit program and small demonstration projects.
Rebates and Incentives	• High efficiency washing machines • High efficiency toilets and waterless urinals • Hotel Awards Program • High Efficiency Fixture Rebates
Regulatory	Revise county code to require high efficiency fixtures in all new construction.

Demand Side Management (Conservation) Program Portfolios.

	Develop a comprehensive water conservation ordinance to include xeriscaping regulations.
Water Use Rates	MDWS currently has a tiered rate structure to encourage conservation (County Code Chapter 14.10). Data improvements underway could enable the Department to move toward a more aggressive tier structure

While many programs are applicable to all public water systems, the economies of scale and customer diversity of MDWS allows it to provide a wide range of programs to its customers; as a department of the County, MDWS is positioned to provide education and outreach to the community at large. Still, various conservation measures should be evaluated to determine whether it would be feasible to apply them to a larger population base through methods such as:

- Adoption of regulations applicable to specified classes of uses, development types, geographic areas, or other categories, regardless of service provider. Examples are requirements for new development or that commercial uses replace specified appliances or fixtures with water-efficient ones within stated timeframes.
- Partnerships to administer, cost-share, or otherwise increase feasibility for smaller water providers, increase adoption rates, etc.

Other Public Water Systems Demand Side Conservation Strategies

Water conservation is applicable to water systems of all sizes, and programs can be tailored to the resources and uses served by the purveyor. The following WUDP policies are derived from and consistent with the goals and objectives established in the General Plan, Maui Island Plan and the WUDP public process to apply island wide:

a. Reduce the demand of existing uses
b. Require aggressive conservation in new development in all areas.
c. Align the level of conservation with availability of local water resources.
d. Employ more aggressive landscape water conservation measures in dry areas than wet areas to mitigate water transport
e. Instill a conservation mindset through community education, 'lead by example,' incentive programs, and conservation pricing.
f. The quality of the water supply should be matched to the quality of water needed, with the highest quality water allocated for the highest uses.

Theses general policies reflect the following strategies, programs and measures summarized in Table 12-5 below.

Table 12-5 Recommended Demand Side Conservation Strategies and Programs for MDWS, Public Water Systems and Non Agricultural Irrigation

Strategies	Uses	Strategy Applicability
Smart meters retrofits	All	MDWS targeted rollout All water systems

Strategies	Uses	Strategy Applicability
Targeted water audits/direct install and sub-metering of multi-unit buildings	Residential Commercial	MDWS large users Public Water Systems
Residential low-flow devices incentives	Residential	MDWS customers All - public events
Residential and commercial water-efficient appliance and toilets incentives and rebates	Residential Commercial	MDWS customers
Targeted public facility water-efficient devices, fixtures and appliances programs	Public	MDWS County parks and facilities retrofits and partnerships
Landscaping and irrigation system incentives, targeting dry areas	Residential Commercial Public	MDWS County parks pilot program
Greywater incentives	Residential Commercial	MDWS pilot program
Rainwater catchment for irrigation	Residential Commercial	Educational - all
Water-efficient standards for fixtures, devices, and systems in new development (such as WaterSense or equivalent)	All	County Code amendment-all development
Water conserving design and landscaping in new development (xeriscaping targets dry areas)	All	County Code amendment-all development
Water-efficient irrigation systems	All	County Code amendment-all development
Water-efficient building design integrating alternative sources (grey water, catchment)	Large users Commercial Multi-family	Incentives or County Code amendment-target development
Low-impact development site design (integrate percolation, retention, capture)	Large users Commercial Multi-family Subdivisions	County Code amendment-target development
Restrict outdoor water waste (no runoff, water wasting, hose nozzles)	Outdoor water use	MDWS, drought rules
Targeted conservation programs in dry areas and drought conditions	Target users	MDWS water shortage rule
Educational, informational and other programs for community at large	All	MDWS
Water conserving landscaping guidelines	All	MDWS
Alternative source guidelines (grey water, rain harvesting, green sites, etc.)	All	MDWS
Market/customer surveys	All	MDWS
Water rates to incentivize conservation	All	MDWS tiered water rates
"Lead by Example" conservation and efficiency projects	All	County Parks Dept/MDWS-fixtures and landscaping programs at County parks and facilities

New development typically includes redevelopment or major improvements that relate to the subject element.

MDWS Supply Side Conservation Strategies

The sustainable and efficient use of water resources, as well as the capacity and integrity of water systems, can be improved by accounting for water as it moves through the system and taking actions to ensure that water loss is prevented and reduced to the extent feasible in accordance with accepted targets.

a. Perform annual comprehensive water audits

A comprehensive water audit program provides a foundation for improving system efficiency and loss control. A water audit provides a data driven analysis of water flowing through a water system from source to customer point-of-service and is the critical first step in determining water supply efficiency and responsible actions to manage and reduce water loss consistent with available source, operational and financial resources.[46] Some of the benefits of water audits include; increased water flow accountability and loss control; deferred source development; guiding leak detection and repair which result in energy and operational savings; and recover lost revenue from unauthorized or unmetered use. [47]

Act 169, Session Laws of Hawaii, 2016, implements the *Hawai`i Water Conservation Plan* by requiring county-owned public water systems including MDWS to submit annual water audits to the CWRM beginning July 1, 2018. Act 169 specifies that audits use the American Water Works Association's *Water Audits and Loss Control Programs, Manual of Water Supply Practices M36* and its *Free Water Audit* software. The software produces financial and operational efficiency outputs and prioritized actions that can be taken to reduce system losses and improve data validity consistent with acceptable levels of water loss for each water system.[48]

b. Fund and implement a continuous leak detection program

Monitoring and repair of identified leaks in water mains and laterals are guided by water audit data. Due to limited resources MDWS must prioritize leak repair. Lack of meters or access along water mains in undeveloped or agricultural areas can problematic in assessing leaks. Improved technologies such as District Metering Areas (DMAs), drone surveying and permanent leak detection on major distribution lines using the appropriate cost-effective technology would be beneficial and should be further explored.

---

[46] USEPA. Using Water Audits to Understand Water Loss. A Joint Presentation of the USEPA Office of Groundwater and Drinking Water and the American Water Works Association, 1/26/2012. https://www3.epa.gov/.../waterinfrastructure/docs/water-audits_presentation_01-2012.pdf *Accessed March 29, 2017.*

[47] Fujii, Neal, Commission on Water Resource Management. DWSR Providing Funding for AWWA Water Audits Coming to a Utility Near You. DOH, The Water Spot, DOH, Volume 20, Issue 4, October 2016. http://health.hawaii.gov/sdwb/files/2016/09/Water_Spot_Volume20_Issue4.pdf Accessed March 24, 2017.

[48] US EPA, Water Audits and Water Loss Control for Public Water Systems https://www.epa.gov/sites/production/files/2015-04/documents/epa816f13002.pdf Accessed March 24, 2017.

Public Water Systems Supply Side Conservation Strategies

This section focuses on public water systems that primarily supply potable water, but the strategies can to varying degrees be applied to other systems.

a. Perform annual comprehensive water audits

Public water systems serving a population of 1,000 or more and those within water management areas regardless of population served are required to submit annual water audits beginning July 1, 2020. This includes the Kapalua Water Company, Ka`anapali Water System, Haleakala and Kipahulu National Park systems, as well as the Hawaii Nature Center which is within the `Iao water management area. Regardless of size, water systems should evaluate the system production data against metered or billed end uses to identify potential water losses. AWWA's *Free Water Audit* software required by Act 169 identifies thresholds to assist water system operators in determining acceptable levels of water loss for their systems. The average water loss for public water systems in the United States is 16 percent, with up to 75 percent of that loss able to be recovered.[49]

b. Maintain and operate the water system to minimize the sources of water loss

Preventive measures extending from design standards to effective maintenance can help ensure systems operate at optimal performance throughout their useful life and that repairs are made proactively. Leaks and water loss may occur at the water meter, in laterals or distribution lines, at source or treatment facilities, or other points in the system. Leak detection is used to locate and verify problematic leak areas in addition to ongoing repair and maintenance operations. Metering, monitoring and analysis of performance indicators can assist in identifying and prioritizing actions ranging from replacement or rehabilitation to preventative maintenance of meters, lines and equipment. In addition to a comprehensive leak detection program, a program for response and repair to large and small leaks, generally identified by the public, is necessary. Concerns were raised in the WUDP public process that irrigation in the rain, broken sprinkler heads and overspray are not addressed at county parks and facilities. The county needs to lead by example.

Conservation Issues and Opportunities for Agricultural Uses

Irrigated agriculture is facing challenges due to limited water supplies, competing uses and the threat of water quality degradation, along with market conditions that require irrigation water

[49] US EPA, Water Audits and Water Loss Control for Public Water Systems https://www.epa.gov/sites/production/files/2015-04/documents/epa816f13002.pdf Accessed March 24, 2017.

users to increase efficiency.[50] Sustainable agriculture and self-sufficiency goals can also be supported by resource conservation and efficiency. Most landscape irrigation is included within the population based demand projections.

Agricultural irrigation water use has been predominately supplied by surface water conveyed by the East Maui Irrigation Company (EMI), Wailuku Water Company, Maui Land & Pineapple Company, former Pioneer Mill and West Maui Water Company irrigation systems to local users and systems including `auwais. MDWS, Ka`anapali Coffee and various land owners are also identified as agricultural water managers in the 2015 State Agricultural Land Use Baseline. MDWS supplies non-potable surface water through EMI's ditch to the Kula Agricultural Park. Creative solutions are needed in order to implement county policies to support agriculture and provide adequate irrigation supply while surface water sources are constrained by higher priority protected public trust needs.

Demand-side management focus on crop and irrigation water use efficiencies and conservation, while supply-side measures focuses on irrigation system efficiencies and alternative supplies.

Crop Demands

Focusing agricultural production on crops adapted to local climate conditions was called for during community meetings on the WUDP in order to reduce irrigation requirements and water transport. Optimal crop yield requires balancing soil-water content between an upper limit at which leaching becomes excessive and a lower point at which crops are stressed.[51] Maximizing capture and use of precipitation can reduce irrigation needs and support sustainability. Regenerative agriculture can hold water in the soil restore the watershed by building healthy soil to improve carrying capacity, planting windbreaks, rotational planting, planting climate adapted crops, efficient irrigation methods, and capturing and storing rainwater.[52]

a. Inform and support less water consumptive crops, climate adapted crops and appropriate water duty.

Analysis to decrease crop consumptive use and increase crop efficiencies should be provided in the Agricultural Water Use & Development Plan. Provide guidance on appropriate crops by climate zone, along with pertinent information on industry organizations and technical partners, federal and state support. Utilize available numerical models for estimating crop irrigation requirements, such as the ArcGIS based numerical simulation model IWREDSS 2.0 that account

[50] USDA-NRCS, *National Engineering Handbook*, Part 623, Irrigation, Chapter 2, Irrigation Water Requirements, 1993, p. 2-1.
[51] USDA-NRCS, *National Engineering Handbook*, Part 623, Irrigation, Chapter 2, Irrigation Water Requirements, 1993, p. 2-1.
[52] Maui Tomorrow, *Malama `Aina: A Conversation About Maui's Future*, March 8, 2016, p. 23.

for water budget, water duty per acre, rain, runoff, evapotranspiration, drainage, irrigation application systems and other factors.[53]

Irrigation Management

Gains in water conservation may be most successful in the area of water use efficiency due to greater control and lower sensitivity to market forces.[54]

- Minimize losses during conveyance to and distribution onsite – diversion, conveyance and delivery losses, seepage and ET loss
- Minimize losses during application to crops – efficient irrigation methods, time planting to take advantage of precipitation, reduce evaporation in field, schedule irrigation based on soil moisture and plant needs, control weeds
- Apply only the amount of water the crop needs
- Apply new technologies for water management

An estimated one-third to one-half of water diverted for irrigation is lost between the source and the point of use in the western US.[55] Irrigation efficiency is an index used to quantify the beneficial use of water diverted for irrigation purposes to the end use, and includes irrigation water management and losses in providing the water to the area irrigated. Water management decisions strongly influence irrigation efficiency for surface water systems, while physical site conditions and irrigation facilities are more important in sprinkler, micro, and subsurface systems. [56] Conveyance system losses result from seepage from the irrigation system, leakage around diversion and other structures and operational spills. Losses up to 50 percent of a diversion can generally be maintained below 10 percent with a carefully managed manually operated system, or reduced even lower with automation technology. At the farm level, field distribution efficiency by the end user is affected by size of irrigated area, water delivery schedule, crops types, ditch lining, and water supplier capabilities.[57]

Table 12-6 Conveyance and Field Distribution System Efficiencies

Project characteristics	**Conveyance efficiency**
• Continuous supply with no substantial change in flow	90%
• Rotational supply, depending on project characteristics	65 – 80%
Irrigation field characteristics	**Field efficiency**

[53] Fares, Ali, Ph.D., CTAHR, UHM. Irrigation Water Requirement Estimation Decision Support System (IWREDSS) to Estimate Crop Irrigation Requirements for Consumptive Use in Hawaii, Final Report prepared for CWRM, August 2013

[54] Adapted from Bellows, Barbara. Irrigation (PPT). National Sustainable Agriculture Information Service, 2004. https://attra.ncat.org/downloads/water_quality/irrigation.pdf This reference is also the source for many of the listed best management practices.

[55] USDA-NRCS, *National Engineering Handbook*, Part 623, Irrigation, Chapter 2, Irrigation Water Requirements, p. 2-181.

[56] NEH, p. 2-164. Irrigation efficiency is the ratio of the average depth of irrigation water beneficially used to the average depth applied, expressed as a percentage.

[57] USDA-NRCS, National Engineering Handbook, Part 623, Irrigation, Chapter 2, Irrigation Water Requirements, 1993, pp. 2-181 to 2-185.

• Irrigated fields >50 acres, unlined / lined ditch or pipeline	80 / 90%
• Irrigated fields <50 acres, unlined / lined ditch or pipeline	70 / 80%

USDA-NRCS National Engineering Handbook, Part 623, Irrigation, Chapter 2, Irrigation Water Requirements, Table 2–53**,** p. 2-185.

The Na Wai `Eha and East Maui Streams Contested Cases provide guidance on unaccounted for water for purposes of the restoration of stream flows under an amended IIFS. In both Contested Cases CWRM used an irrigation efficiency factor of 85 percent. In the East Maui Contested Case, EMI's irrigation reasonable and beneficial losses were calculated at 22.7 percent of total water uses including all HC&S uses, deliveries to MDWS and other uses. Of 22.7 percent, about 10 percent was attributed to system losses of water to irrigate HC&S fields (seepage, transportation and storage ET, reporting and system inefficiencies).[58] In the Na Wai `Eha Contested Case, Wailuku Water Company's reasonable system losses were five percent (2.73 mgd) and WWC estimated that lining the unlined portions of the ditches could further reduce system losses by about 29 percent;[59] HC&C's reasonable losses were 2.15 to 4.20 mgd (HC&S indicated an approximately 20 percent loss rate is 4 to 5 mgd).[60]

Political and legal questions are raised where those that benefit from conservation are not responsible for the cost. For example, while improvement of an irrigation system to reduce the amount of water diverted would provide more water for downstream users, the upstream user would not benefit and may not be incentivized to improve efficiency.[61] Establishment of IIFS and water use permits provide a foundation for addressing this issue. Case law (Wai`ahole II) establishes that "[o]ffstream users have the burden to prove that any system losses are reasonable beneficial by establishing the lack of practicable mitigation measures, including repairs, maintenance, and lining of ditches and reservoirs. … Whether or not a permit is required for system losses, off-stream users, and ultimately the Commission, must account for water lost or missing by adopting "provisions that encourage system repairs and limit losses."[62]

[58] CWRM Hearing Officer's draft January 15, 2016 Minute Order, East Maui Streams Contested Case (CCH-MA13-01), pp. 60, 72-74. Total water uses characterized by HC&S as surface water delivered and ground water pumped. 85% consistent with industry standard and minimum drip irrigation efficiency design and consistency with the Irrigation Water Requirement Estimation Decision Support System estimating crop water requirements for consumptive use permitting in Hawaii. The USGS study, "Measurements of Seepage Losses and Gains, East Maui Irrigation Diversion System, Maui, Hawaii" determined it is not clear whether net seepage losses occur in the EMI diversion system.

[59] Calculation of 29%: WWC estimated a reduction of about 800,000 gpd from lining unlined ditches at approx. cost of $5,026,000; (800,000 gpd of 2.73 mgd = 29%). Stipulation Re Mediator's Report of Joint Proposed Findings of Fact, Conclusions of Law, Decision and Order in re Petition to Amend Interim Instream Flow Standards of Na Wai `Eha Contested Case Hearing (CCH-MAO6-O1), April 4, 2014, Finds of Fact, p. 17.

[60] Stipulation Re Mediator's Report of Joint Proposed Findings of Fact, Conclusions of Law, Decision and Order in re Petition to Amend Interim Instream Flow Standards of Na Wai `Eha Contested Case Hearing (CCH-MAO6-O1), April 4, 2014, Finds of Fact, pp. 14-18.

[61] USDA-NRCS, *National Engineering Handbook*, Part 623, Irrigation, Chapter 2, Irrigation Water Requirements, 1993, p. 2-225.

[62] CWRM's Findings of Fact, Conclusions of Law, and Decision and Order in re Petition to Amend Interim Instream Flow Standards Na Wai 'Eha Contested Case Hearing, June 10, 2010 (CCH-MAO6-O1), p. 131-132. [Waiãhole I, 94 Raw. at 172-73, 9 P.3d 29 at 484-85; Waiãhole II, 105 Raw. at 27, 93 P.3d at 669]

Many intake systems were designed to take the entire base flow and discharge excess further down the ditch system, impacting natural flows and protection of native stream biota and appurtenant rights of taro growers downstream. New intakes and automated management systems may be helpful.[63] The CWRM determined that lo'i consume 15,000 to 40,000 gad and leakage from the inflow and outflow ditches must be reduced as much as practically possible.[64] Irrigation efficiencies of commonly grown crops with typically used irrigation systems indicate many crops typically use drip systems.[65] With proper irrigation method, crop and site conditions, and a high level of management, the efficiency of any irrigation system can be increased to the low to mid 90's.[66] Irrigation efficiency can be increased by about 15 percent by converting from sprinkler to drip irrigation.

Table 12-7 Common Crops, Typical Irrigation Systems, and Irrigation Efficiencies (%)

Crop	Irrigation	Efficiency	Crop	Irrigation	Efficiency
Avocado	Drip	85	Melons	Drip	85
Banana	Micro-spray	80	Pineapple	Drip	85
Breadfruit	Drip	85	Papaya	Drip	85
Cabbage	Drip	85	Seed Corn	Drip	85
Coconut palms	Drip	85	Sweet potato	Drip	85
Coffee	Micro-spray	80	Sugarcane	Drip	85
Domestic garden	Sprinkler	75	Taro (dry)	Drip	85
Koa	Micro-spray	80	Taro (wet)	Flood	50
Lettuce	Sprinkler	70	Turf, golf	Sprinkler	75
Macadamia nut	Micro-spray	80	Turf, Landscape	Sprinkler	75

Fares, Ali, Ph.D., CTAHR, UH-M. Irrigation Water Requirement Estimation Decision Support System (IWREDSS) to Estimate Crop Irrigation Requirements for Consumptive Use in Hawaii, Final Report, August 2013, Tables 1 and 2, pp. 6-7.

a. Improve irrigation management and efficiency

Promote education and resources to farmers and private water purveyors to increase adoption of cost effective conservation methods. Catalyze and support efforts to enhance agricultural sustainability and self-sufficiency consistent with county policy using industry organizations and technical partners such as University of Hawaii College of Tropical Agriculture and Human Resources, US Department of Agriculture, Soil and Water Conservation District, Hawai`i Agriculture and Education Departments; Hawai`i Farm Bureau Federation, and Hawai`i Organic Farmers Association.

[63] 2015 State Agricultural Land Use Baseline, pp. 84-85.
[64] CWRM's Findings of Fact, Conclusions of Law, and Decision and Order in re Petition to Amend Interim Instream Flow Standards Na Wai 'Eha Contested Case Hearing, June 10, 2010 (CCH-MAO6-O1), p. 168.
[65] Fares, Ali, Ph.D., CTAHR, UH-M. Irrigation Water Requirement Estimation Decision Support System (IWREDSS) to Estimate Crop Irrigation Requirements for Consumptive Use in Hawaii, Final Report prepared for CWRM, August 2013.
[66] USDA-NRCS, *National Engineering Handbook*, Part 623, Irrigation, Chapter 2, Irrigation Water Requirements, 1993, p. 2-164.

b. Maintain the integrity of plantation irrigation systems including reservoirs

Explore funding and support maintenance and improvements to Maui's plantation conveyance systems to mitigate losses. A cost benefit analysis is warranted to assess how system improvements to reduce losses can offset groundwater development and compare to alternative resources. A strategy to preserve existing reservoirs at risk of decommissioning is needed to continue and expand raw water storage, which is key to managing drought conditions, taking advantage of periodic flows, and planning for climate change.

Water Supply Management

The use of surface and ground water supplies can be reduced or optimized through increased storage, reuse and use of alternative sources. Capture of rainfall and runoff along with retention of surface water delivered and storage in ponds or reservoirs can reduce the need for other water resources. MDWS may also be called on to increase delivery of potable water for agricultural needs as the Food Safety Modernization Act requires use of treated water to wash crops and prepare them for market

Increased use of alternative sources such as recycled water and stormwater reuse is consistent with County policy and community sentiment expressed to reduce transport and align water quality levels with use. While the Food Safety Modernization Act poses challenges, increased use of recycled water can offset irrigation needs for some crops in some areas, with the potential to reduce injection of unused recycled water. Reuse of irrigation water prior to discharge where feasible can increase irrigation efficiency and reduce runoff or disposal of drainage containing elevated chlorides, agricultural chemicals, or sediments. County plan policy supports maximizing the use of alternative supplies to serve non-potable needs.

a. Augment agricultural water supplies with alternative resources

Maximize the use of alternative resources for agriculture and irrigation, even if not the lower cost option. Support implementation of stormwater capture for agricultural end uses. This strategy is further discussed under Section 12.4.3

The table below summarizes conservation strategies related to agricultural irrigation.

Table 12-8 Recommended Conservation Strategies and Programs for Agricultural Uses

Strategies	Applicability
Research, support and use of less water consumptive crops and climate adapted crops	State Department of Agriculture, Industry/technical groups supported by state/federal policy
Improve irrigation management and efficiency	Industry/technical groups supported by state/federal policy

Maintain the integrity of plantation irrigation systems including reservoirs	Public-private partnerships: East Maui Irrigation Co, Wailuku Water Co, West Maui Land, Maui County, State Dept of Land & Natural Resources, State Dept of Agriculture
Augment agricultural water supplies with alternative resources	County Dept of Public Works, State Dept of Land & Natural Resources, State Department of Agriculture

Drought and Climate Change Scenarios

An aggressive water conservation program is a critical component of drought mitigation, especially during the dry and/or summer months. Conservation can address climate change by increasing resilience to declining water supply or more frequent or longer droughts and their related effects. A priority action recommended in the *Hawai`i Drought Plan 2017 Update* is to "Support water conservation, reuse, and recharge measures in Hawaii as part of increasing freshwater security."[67] The summary of conservation and reuse strategies for the State of Hawaii are similar to those recommended in this WUDP chapter:[68]

- Continue to implement the Hawaii Water Conservation Plan.
- Encourage the county water departments to develop their own water conservation plan.
- All levels of government, the private sector, and stakeholders should be involved in conservation activities and should actively develop new water conservation programs where needed.
- Development of coordinated plans to implement water restriction practices, voluntary and mandatory, if a drought is either imminent or exists. Establish regional water shortage provisions and policy for guidance and drought-related emergencies.
- Dissemination of information to the public about water conservation measures.
- Continued development of media campaigns to solicit public support and cooperation for the effective and prudent use of water.
- Development of incentive programs or tax credits for installing water saving fixtures. Offer free inspections to identify leaking toilets and plumbing fixtures.
- Continue implementation of the Hawaii Water Audit Validation Effort.
- Support and encourage water-conserving irrigation systems, irrigation management practices, and water conservation practices, such as windbreaks and cover crops.
- Encourage use of rainwater catchment for outdoor water uses and irrigation.
- Continue to encourage source water use reporting and end use metering.
- Support use of reuse, greywater and dual water systems, and stormwater utilities.
- Increase water reuse for large landscaped areas.

[67] Hawai`i Drought Plan 2017 Update (January 2017 Draft), prepared by One World One Water for CWRM, p. 91.
[68] Hawai`i Drought Plan 2017 Update (January 2017 Draft), prepared by One World One Water for CWRM, p. 83.

The strategies and programs in this chapter also support the *Hawai'i Climate Change Adaptation Priority Guidelines Tools* for local government:

- Identify potential steps and barriers for avoiding over-allocation of groundwater, such as implementing demand-side conservation measures
- Prepare and implement mandatory water conservation and recycling plans
- Increase resilience to declining water supply or more frequent drought by implementing mandatory water conservation and recycling
- Incorporate water-conserving infrastructure and practices into new development and redevelopment
- Enhance "green-building" efforts with county rebates and utility credits directed at conservation.

Conservation and Efficiency Related to Energy (Demand/Supply Side Management)

Issues and Opportunities

The cost of energy is the largest cost of water production. Water conservation programs applied to potable and alternative water sources reduce the costs of developing, moving, storing and treating water, thereby conserving energy and reducing cost. Water utilities have an opportunity to improve energy efficiency and load management and generate and use renewable energy. Benefits include lower costs, increased sustainability, energy independence and security, reduced environmental degradation and health impacts, and other benefits associated with climate change mitigation and adaptation.

The State goal to generate 100 percent of the state's electricity with renewables by 2045 (HB 623, June 8, 2015) will be implemented by the energy utilities and drive policy at all levels of government. MECO's updated Power Supply Improvement Plan calls for 100 percent renewable energy by 2040 and MIP Energy Objective 6.10.1 proposes to reduce fossil fuel consumption by 30 percent from 2010 to 2030.

MDWS Energy Efficiency and Production

MDWS is the largest single consumer of electricity on Maui and participates in MECO demand response programs which incentivize energy users through agreements to alter the timing, level of instantaneous demand, or the total electricity consumption.

Opportunities to increase energy efficiency, manage electrical loads and generate electrical energy provide benefits to the County, MDWS customers and MECO. Most energy consumed is used to operate motors for pumps that lift water to storage tanks and reservoirs. This is most significant for the Upcountry System where water from the basal aquifer near sea level is conveyed to elevations ranging from 1,000 to 4,000 feet; electrical costs for pumping water 1,000 feet is roughly $1.50 per 1,000 gal water. When pumped to MDWS distribution at an elevation of 4,000 feet, the pumpage cost far exceeds the average customer water rate charge of about $4 per 1,000 gallons of water.

The MDWS system has the capability to provide short-term "stabilizing" load management to accommodate MECOs growing proportion of variable renewable energy sources, which could benefit both MECO and MDWS customers.[69]

Renewable energy production opportunities are site specific due to the nature and availability of renewable energy sources and proximity to MDWS system electrical loads. MDWS facilities have limited land area necessitating access to land for power generating installations.[70] MDWS has opportunities to produce renewable energy to offset its own while reducing system costs. Options identified to date include using water from high-level tunnels to produce hydroelectric power, wind generation to support the Upcountry system, photovoltaic installations through third parties; and an inline hydroelectric project at the Mahinahina WTF are under evaluation.

Other Public Water Systems

There are a wide range of opportunities to improve efficiency and increase the use of alternative energy resources, albeit at a smaller scale than is possible for MDWS, through an audit of existing facilities, equipment and vehicles and systematic planning and purchasing for future system, operations and maintenance. Coordination and partnerships with industry groups such as Hawaii Waterworks Association, MDWS and MECO can help mitigate limited resources.

Objectives

a. Energy efficiency and production measures advance several of the WUDP planning objectives including: Cost, Efficiency, Environment, and Sustainability

General Plan Policies

a. Support energy efficient systems, processes, and methods in public and private operations, buildings, and facilities.
b. Support the establishment of new renewable energy facilities at appropriate locations provided that environmental, view plane, and cultural impacts are addressed.
c. Encourage all new County facilities completed after January 1, 2015, to produce at least 15 percent of their projected electricity needs with onsite renewable energy.

Recommended Strategies

a. Pursue comprehensive energy management

Similar to water audits, energy audits should be used as a basis for identifying energy inefficiencies and opportunities. Programmatic coordination is needed between the water

[69] Freedman, Carl, Haiku Design and Analysis. Maui County Water Use and Development Plan, Central DWS District Update, Nov. 16, 2010, p. 23.
[70] Freedman, Carl, Haiku Design and Analysis. Maui County Water Use and Development Plan, Central DWS District Update, Nov. 16, 2010, p. 110.

purveyor, Maui Electric Company, the County Energy Management Program, the State and utility sector programs.

b. Increase energy efficiency and improve load management

The greatest energy reduction opportunities are the result of water conservation and efficiency. Investing in high efficiency equipment where cost-effective, establishing system operation protocols that consider energy efficiency and participating in load management incentive programs should be considered by all water purveyors.

c. Increase alternative energy generation and use

Reduction in the use of fossil fuels by facilities, equipment, vehicles, and operations through energy efficiency and conversion to other technologies contributes to State and MIP objectives. The MIP calls for increases in renewable energy production and working with the Energy Management Program in their efforts to produce an energy audit of County facilities, operations, and equipment; develop programs and projects to achieve greater energy efficiency and reduction in fossil fuel use; and phase out of inefficient fossil-fueled vehicles. Water purveyors should monitor and implement cost-effective alternative energy generation opportunities.

12.3 CONVENTIONAL WATER SOURCE STRATEGIES

Between the two mountain ranges on Maui, Mauna Kahalawai and Haleakala, naturally occurring water sources can be broadly described as East Maui groundwater, East Maui surface water, West Maui groundwater and West Maui surface water. These are considered conventional water sources. Conservation and efficiency measures can reduce the utilization of water and delay source development.

Ground Water Development

Island wide, groundwater supplies about 70% of drinking water needs. Aquifers on the wet windward side are sustained by high rainfall with 60% of the island's recharge occurring in Ko`olau and Hana aquifer sectors. To support current population centers, groundwater is moved from sources to where it's needed. Sources in the Wailuku Sector provides most of the freshwater supply for communities spanning from Waihee to Paia on the north shore, Kahului, Waikapu and transmitted across the Central isthmus to the Kihei-Makena region. The Maui Island Plan explicitly directs growth to areas where there is available infrastructure capacity. A recurring concern raised in the WUDP public process to reduce water transport needs to be balanced with the need to support planned growth areas with reliable water supply.

<u>Groundwater Availability Issues</u>

The amount of groundwater that can be developed is limited by the amount of natural recharge and aquifer outflow that contribute to streamflow and to prevent seawater intrusion, established as sustainable yield. Because delineation of aquifer sectors and systems in some cases are based on limited hydrologic information, areas for potential groundwater development must be assessed on its own merits to determine any additional needs for hydrologic studies and interaction with surface water and other sources.

Understanding potential impact of climate change adds to uncertainty in long-term groundwater availability. The primary responsibility to determine potential impacts on water resource availability lies with the State CWRM who in turn relies on studies and predictions by the scientific community and other agencies. Water purveyors need guidance how to mitigate and adjust to potential changes in groundwater availability.

Other constraints on groundwater availability include access and cost. Conveyance from high yield aquifers in remotely located watersheds to growth areas can be difficult and expensive due to topography and distance. Basal well development at high elevations, such as Makawao aquifer above 1200 feet would result in high pumping costs, just in terms of pumping water from the water table to ground elevation.

Adding wells in already developed aquifers must also consider distribution of pumpage. Development adjacent to existing infrastructure is preferred from a cost perspective, but adding transmission to distribute wells further throughout an aquifer system may be warranted to optimize pumpage and mitigate aquifer impact.

State CWRM designation of groundwater management areas provides more oversight by the CWRM in accordance with the State Water Code Section 174-C-41. It does not change established sustainable yield or pumpage distribution but allocates water use by permit within sustainable yield. Water use permits for the Iao aquifer, designated a groundwater management area in 2003, exceed 95% of sustainable yield.

Water availability has been a much debated issue since the adoption of the County Availability Rule, codified in Maui County Code Section 14.12. The rule applies to the MDWS systems and only addresses residential developments. The current rule does not clearly distinguish between long term water supply available by infrastructure, including developed source capacity, or long term water supply in terms of resource limits, defined as sustainable yield and in-stream flow standards. Community concerns raised with regards to the current policy range from excessive burden on private developers to supply water source; a convoluted process that impedes development of much needed housing; lack of expertise by MDWS to complete the rigorous assessment mandated in the rule; loop holes that exempt commercial development and non-county water systems from the rule; proliferation of small private water systems around the island versus a cohesive government-managed water system; and inadequate protection of the

resource. The rule has been largely blamed for blocking small to medium-scaling housing from being built. [71]

Objectives

a. Provide adequate volume of water to timely serve planned growth in MIP
b. Increase capacity of water systems in striving to meet the needs and balance the island's water needs
c. More comprehensive approach to water resource planning to effectively protect, recharge and manage water resources
d. Ensure stable chloride levels in developed wells

General Plan Policies

d. Acquire and develop additional sources of potable water.
e. Seek reliable long-term sources of water to serve developments that achieve consistency with the appropriate Community Plans.
f. Capitalize on existing infrastructure capacity as a priority over infrastructure expansion.
g. Ensure that MDWS actions reflect its public trust responsibilities toward water
h. Ensure that the WUDP implements the State Water Code and MIP's goals, objectives, and policies
i. Ensure that the County's CIP for water source development is consistent with the WUDP and MIP
j. Ensure that adequate supplies of water are available prior to approval of subdivision or construction documents

Recommended Strategies

a. Support collaborative hydrogeological studies to inform impact from climate change and future well development on groundwater health.

Potential effects of groundwater development on streamflow and on the quality of water pumped from existing wells in a region can be evaluated by robust hydrologic studies and models. Joint funding and collaboration between the municipal and private purveyors, CWRM and the U.S. Geological Survey would focus studies to maximize benefits and prevent conflicts in water development and designation. The strategy urges the CWRM to prioritize hydrological studies and groundwater modeling in regions of planned well development. Study and modeling results should guide individual well development that mitigates salt water intrusion and impacts to adjacent sources and surface water, optimizes pumpage of existing wells to avoid negative impacts and assist CWRM in assessment and updates of sustainable yield.

[71] Public Testimony, Maui County Council Water Resources Committee meeting January 6, 2016

b. Develop groundwater provide sufficient supply for growth, maintaining a buffer to sustainable yield in order to conservatively account for potential future drought impact and prospective adjustments in aquifers lacking hydrologic studies.

Groundwater sources remain a cornerstone in serving reliable and adequate volume to current and new customers for municipal and privately owned system in the long term. While other strategies such as conservation and alternative resources can alleviate and delay development of new groundwater sources, carefully planned well development is required in all aquifer sectors to meet anticipated growth. Limiting well development in any aquifer system to below sustainable yield addresses community concerns for an additional resource buffer, especially in aquifer systems where confidence ranking of sustainable yield is low due to lack of hydrologic data. The strategy would inform CWRM decisions in their administration of well construction and pump installation permits in aquifers where pumpage approaches sustainable yield. Although changes in recharge and yield due to climate change cannot be reliably predicted over the 20 year time frame, a prudent approach is to distribute well development and pumpage throughout and between aquifer sectors rather than maximizing pumpage up to individual aquifer systems' sustainable yield. Limited groundwater transport in conjunction with aggressive conservation can alleviate stress on aquifer systems underlying infrastructure and growth areas, even though regional resource use is generally more economic. For instance, growth areas in dry Central and South Maui are supported by infrastructure but lack sufficient regional water resources to supply population growth. Withdrawals in Waikapu aquifer to the north-west and Haiku aquifer system to the east are negligible with about 29 mgd of sustainable yield undeveloped. Conservative buffers can be maintained well below sustainable yields. Well development by municipal and private purveyors should be guided by hydrogeological studies as defined in the preceding strategy to ensure no negative impact on surface waters.

c. Promote the highest quality water for the highest end use.

Groundwater on Maui is generally of excellent quality, requiring minimum treatment. Especially high level groundwater, available in some areas as tunnel or spring water, is of pure quality and does not necessitate pumping from sea level to area of service. Prioritizing high level and good quality groundwater for potable needs and using brackish, semi-brackish and otherwise compromised quality water for non-potable uses can be achieved through collaborative agreements between water purveyors, dual distribution systems and increased use of alternative resources for non-potable demand. Dike confined high level water, available through tunnels or springs, generally contributes to base flow. High level tunnels and springs are addressed by CWRM for the designated surface water management area of Na Wai Eha. Withdrawals from tunnels or high level wells in Ko`olau ASEA have historically contributed to the EMI ditch flow but is not specifically addressed in the East Maui streams contested case. Contribution from high level tunnels in the Lahaina ASEA to regional stream flow should be further explored by CWRM in assessment and establishment of Instream Flow Standards.

d. Protect and prioritize public trust uses in allocating groundwater in regions of limited resources and conflicting needs.

The Hawai'i Supreme Court has identified four trust purposes, which are equally protected under the law:

- Maintenance of waters in their natural state;
- Domestic water use of the general public, particularly drinking water;
- The exercise of Native Hawaiian and traditional and customary rights, including appurtenant rights; and
- Reservations of water for Hawaiian Home Land allotments.

In accordance with the principles for the water resources trust identified by the Court, the State and the County should in planning and allocating groundwater resources protect public trust uses whenever feasible; weigh competing public and private water uses on a case-by-case basis, with a presumption in favor of public use, but also accommodate non-public trust uses to promote the best economic and social interests of the people of the State. The State CWRM has an additional duty, set forth in the State Water Code 174C-101, to protect adequate reserves of water for foreseeable needs of Hawaiian Homelands.

As illustrated under Resource Adequacy in section 11, demand based on population growth can be met by available groundwater yield, even under drought conditions. The full build-out of County Zoning scenario, where demand would exceed the island conventional water resources, is considered unrealistic because it is not coordinated with population projections, or taking into account forecasted economic conditions over the planning period. Agricultural demand has by far the greatest potential for fluctuation in estimated demand over the planning period. Where affordable untreated surface water use for agricultural irrigation is constrained by the current legal environment and stricter Food and Drug Administration (FDA) standards, demand for groundwater as an irrigation source could increase.

Projected water use is difficult to break down between public trust and non-public trust categories. While agricultural irrigation is not a recognized public trust purpose, the Maui Island Plan objectives and policies support reliable and affordable water supply for agriculture.

Municipal use can be generally categorized as serving a public trust purpose, or at the very least include a public trust purpose. The State Water Code defines municipal use as “domestic, industrial, and commercial use of water through public services available to persons of a county for the promotion and protection of their health, comfort, and safety, for the protection of property from fire, and for the purposes listed under the term ‘domestic use’.” Non-potable needs for outdoor residential irrigation can be estimated but not quantified without dual irrigation meters.

This strategy promotes the use of non-potable water in place of groundwater whenever feasible for non-public trust uses. Groundwater should be prioritized for municipal and domestic uses consistent with MIP growth strategies; Department of Hawaiian Homeland needs as assessed in DHHL regional plans. Groundwater should be provided for agricultural irrigation

as contingency where other water supply sources are not feasible. Development of groundwater must consider any impact on the exercise of Native Hawaiian and traditional and customary rights, further described in the Ka Pa'akai analysis, Appendix 9. County policy and code can prioritize developed groundwater source capacity for domestic and municipal development that is consistent with the MIP directed growth and for DHHL needs. Regional groundwater development strategies are defined for each Aquifer Sector.

e. Increase monitoring of groundwater sources to assess water and chloride levels in potable and non-potable wells throughout developed aquifers

Monitoring wells provide information on changes in water levels and chlorides over time. This data is crucial to track overall aquifer impact and potential impact on stream resources within the aquifer system. Continuous data help assess the status and trends of groundwater resources and to make adjustments to pump rates and distributions. Monitoring wells are present in Wailuku aquifer sector but lacking in most other groundwater regions.

f. Promote well siting and distribution strategies for all public water systems to ensure optimal spacing and withdrawals for aquifer health and equitable use

Equitable resource use includes access to available resource at reasonable cost. Cost is directly related to the elevation and proximity to infrastructure while access is closely tied to land ownership. Traditionally, well development in the state is on a first come first serve basis that results in the cheapest source being developed first. As demand requires new source development, existing well fields that originated decades ago have expanded piecemeal, largely driven by the underlying land ownership and cost. Collaboration, rather than competition between water purveyors is needed to achieve "smart" source development that ensures:

1. Optimized distribution of withdrawals based on hydrologic models and studies
2. Potable water quality that is protected from existing and future contamination sources
3. Wells that serve development in compliance with the Maui Island Plan growth strategies
4. Regional resource preservation to meet future demand for public trust uses

Well siting standards that distribute well development spatially and avoid areas of potential contamination, agreements to preserve resources for public trust uses can be attained by County wide policy and public-private partnerships. This strategy should guide land use developments to diversify water supply and collaborate on source development that distributes withdrawals for aquifer health.

g. Formalize demand response plans for water purveyors that address water shortage and aquifer changes.

Except for designated water management areas, purveyors are not required to have response plans in place that address water shortage due to increased demand, drought or the impact to chloride content of individual wells. Reporting by water purveyors to the CWRM does not necessarily trigger improved management of individual water systems or well fields. This

strategy promotes formalizing action plans and alternative pump rate scenarios for all wells in response to declining water levels, increases in chlorides or escalated pumpage to protect aquifer health. Purveyors should develop critical chloride and pump level tresholds for representative wells in each developed aquifer region or wellfield, and define response actions. Thresholds should trigger actions to mitigate impacts on aquifers, such as reduced pumpage in combination with alternative resource use and conservation measures.

h. Develop a water availability rule to provide certainty in land use planning and ensure that reliable source and infrastructure capacity is provided within reasonable time for planned growth.

Water availability has been a much debated issue since the adoption of the County Availability Rule, codified in Maui County Code Section 14.12. The rule applies to the MDWS systems and only addresses residential developments. To address community concerns and uncertainties of the current county Availability Rule, at the onset we need to distinguish resource availability from infrastructure availability. Availability rules should clearly define whether limitations apply to system infrastructure, including developed source capacity, or resource availability defined as sustainable yield and in-stream flow standards. Resource adequacy is the fundamental basis in planning development of new water supply sources. The pace of developing water supply should ideally correspond to and precede anticipated demand based on planned growth in the Maui Island Plan. Municipal source development generally occurs on a 5 – 10 year basis subject to capital improvement budget approved annually by council. Reliable and sufficient level of funding is necessary for timely development of needed source and related infrastructure, such as transmission.

<u>Groundwater Reliability and Efficiency Issues</u>

Efficiency measures in water supply and demand side are addressed under Section 12.2 Conservation. Efficient use of infrastructure entails source development that implements the MIP Directed Growth Plan and capitalizing on available infrastructure capacity. Reliability generally means adequate water quantity and quality, pressure and response. Groundwater is considered more reliable supply than surface water, recycled water, storm water reuse and catchment and is the corner-stone for backup source to surface water and alternative water resources in short and long term droughts.

In Central Maui, less than 5 % of drinking water supply is surface water. In West Maui the ratio is roughly 50/50 and Upcountry 80% surface water/20% groundwater. Anticipated growth in designated growth areas can be met with a portfolio of resources to ensure sufficient, reliable, long term supply. Although planned growth in Upcountry would require less than 1 MGD of additional supply, the demand estimated to satisfy the Upcountry Meter List will require up to 7.5 MGD of additional supply by 2035.

<u>Objectives</u>

a. Increase the efficiency and capacity of the water systems in striving to meet the needs and balance the island's water needs

b. Direct growth in a way that makes efficient use of existing infrastructure and to areas where there is available infrastructure capacity

General Plan Policies

a. Ensure the efficiency of all water system elements including well and stream intakes, water catchment, transmission lines, reservoirs and all other system infrastructure
b. Work with appropriate State and County agencies to achieve a balance in resolving the needs of water users in keeping with the water allocation priorities of the MIP
c. Acquire and develop additional sources of potable water
d. Ensure a reliable and affordable supply of water for productive agricultural uses
e. Capitalize on existing infrastructure capacity as a priority over infrastructure expansion
f. Develop and fund improved water-delivery systems

Recommended Strategies

a. Increase system flexibility so that regional sources can be moved to support areas of need, both within the municipal systems and between regional public water systems.

Interconnection between separate but adjacent water systems provides an added amount of redundancy of source, production equipment and electrical power to ensure reliable service. Constraints include mixing of supply sources with potential impact on water quality. Introduction and blending of supply sources require Department of Health approval. Economic benefits would result from interconnection when abundant less expensive surface water is available in wet season to supplement areas regularly served by groundwater supply. Reducing withdrawals of aquifers allows displaced groundwater resources to recharge.

b. Ensure that public/private groundwater development agreements reflect the public trust needs and are in keeping with the water allocation priorities of the MIP.

County Code currently requires water source development agreements between the county and private entities to be approved by resolution. In compliance with the directed growth strategy adopted in the MIP, such agreements should ensure that source provides for development of appropriate locations and uses. For example, irrigation needs for new commercial or resort development, not a protected public trust use, should to the extent feasible be met by non-potable sources.

c. Develop groundwater to maximize reliability of potable supply and as contingency in areas currently dependent on surface water.

Upcountry Maui (Kula, Makawao and Pukalani to Kaupo) are particularly at risk to drought and its' impact on water supply. The vulnerability to drought is highly dependent on the source of water supply. Although technically feasible, development of sufficient new basal wells to meet 100% of projected demand in the MDWS Upcountry system along with booster pumps, the high capital and pumping costs makes this option economically less desirable. A preferred option is to operate ground and surface water resources in the most economical manner during normal conditions with sufficient groundwater contingency source to supplement available surface

water during droughts. This strategy is consistent with measures recommended for Upcountry by the Maui Drought Committee.[72] Haiku and Makawao aquifer sectors are preferred options based on available yield, elevation and connection to the existing distribution system, further discussed under Section 15 Central ASEA.

d. Diversify supply for agricultural use to increase reliability.

Agricultural irrigation has historically relied on affordable untreated surface water in West Maui, Central and Upcountry regions and plantation distribution systems. Affordable and reliable water supply to support agriculture is consistent with general plan policies and community plan objectives. In balancing competing water needs, agricultural irrigation is not a protected public trust use and should be rigorously scrutinized in terms of efficiency and needs. Based on public input efficiency should increasingly consider ambient rainfall and climate appropriate crops. A diversified supply is needed that combines sufficient reservoir storage to take advantage of high stream flows in wet season and to capture stormwater and regional rainfall, with non-potable groundwater as contingency in long-term drought periods. It would be cost prohibitive to develop municipal potable groundwater and infrastructure capacity as contingency for agricultural zoned land. Expansion of cultivated agricultural land cannot be serviced by municipal potable supply but should identify alternative contingency sources.

Surface Water Development

There are essentially three areas on Maui where competing instream and off stream use of surface water are at issue. The Na Wai 'Eha contested case is within a surface water management area wherein CWRM determines the amount of water the end users are allowed to divert from the streams. The East Maui contested case addresses the instream flow standards and how much water must be left in the streams. In West Maui, CWRM is developing watershed assessments to support a determination of instream flow standards.

A key concern derived from community workshops and meetings is the impacts of transport and off stream uses of streams on the ecosystem, public trust and other local uses. Discussions centered around alternative ways to meet future water needs of dependent regions. These concerns are reflected in the Public Trust Doctrine and the protections provided by the State Constitution (Article XI, Section 7) and the State Water Code (Hawai'i Revised Statutes, Chapter 174-C). HRS §174-C-2(c) specifies, “The state water code shall be liberally interpreted to obtain maximum beneficial use of the waters of the State for purposes such as domestic uses, aquaculture uses, irrigation and other agricultural uses, power development, and commercial and industrial uses. However, adequate provision shall be made for the protection of traditional and customary Hawaiian rights, the protection and procreation of fish and wildlife, the maintenance of proper ecological balance and scenic beauty, and the preservation and enhancement of waters of the State for municipal uses, public recreation, public water supply, agriculture, and navigation. Such objectives are declared to be in the public interest.”

[72] Wilson Okamoto Corporation, County of Maui Drought Mitigation Strategies, 2012 Update

The four public trust purposes identified by the Hawai'i Supreme Court as equally protected under the law are also subject to the following principles for the water resources trust identified by the court in the Waiahole and the Wai`ola o Moloka`i cases discussed under Section 1.1.

- The State has both the authority and duty to preserve the rights of present and future generations in the waters of the State;
- This authority empowers the State to revisit prior diversions and allocations, even those made with due consideration of their effect on the public trust;
- The State also bears the affirmative duty to take the public trust into account in the planning and allocation of water resources and to protect public trust uses whenever feasible;
- Competing public and private water uses must be weighed on a case-by-case basis, and any balancing between public and private purposes begins with a presumption in favor of public use, access, and enjoyment;
- There is a higher level of scrutiny for private commercial uses, with the burden ultimately lying with those seeking or approving such uses to justify them in light of the purposes protected by the trust; and
- Reason and necessity dictate that the public trust may have to accommodate uses inconsistent with the mandate of protection, to the unavoidable impairment of public instream uses and values. Offstream use is not precluded but requires that all uses, offstream or instream, public or private, promote the best economic and social interests of the people of the State.

Because the CWRM is charged with balancing public trust purposes and other beneficial uses, it is assumed that final IFS will adequately provide for kuleana and taro water requirements and other in-stream uses. In revising the IIFS, the CWRM concluded that establishing continuous stream flow from mauka to makai provides the best conditions for re-establishing the ecological and biological health of stream waters.

Surface Water Availability Issues

There is no standard flow that is deemed adequate to meet instream needs. However, base flow is a general guideline for the minimal amount of streamflow needed for fish habitat. [73] Conflicting instream and off stream uses become particularly apparent during dry conditions. Flow exceeded 90% of the time (Q_{90} flow) is commonly used to characterize low flows.

As IFS for East Maui Streams and Na Wai 'Eha are not yet adopted due to the reopening of contested cases following the cessation of sugarcane cultivation, plausible scenarios of available stream water for off stream uses were assessed with input from the Aha Moku, the agricultural community and the general public. IFS does not quantify off stream uses. Only in the designated surface water management area Na Wai Eha, are off stream uses allocated through water use permits. In West Maui, where the assessment and establishment of measurable IFS have just begun, an inventory and assessment of available data was done to

[73] Trends in Streamflow Characteristics at Long-Term Gaging Stations, Hawai'i. USGS SIR 2004-5080

estimate instream and off stream uses and needs. The interim IFS adopted in 1988 reflect diversions at the time of adoption with no scientific basis and therefore only provide limited guidance as it relates to historic uses. Significant new stream diversions would require amendments to IIFS.

Objectives

a. Greater protection and enhancement of watersheds, streams, and riparian environments
b. Enhance the vitality and functioning of streams, while balancing the multiple needs of the community

General Plan Policies

a. Encourage the State to mandate instream assessment to provide adequate water for native species.
b. Maui will protect all watersheds and streams in a manner that guarantees a healthy, sustainable riparian environment
c. Work with appropriate agencies to establish minimum stream flow levels and ensure adequate stream flow to sustain riparian ecosystems, traditional kalo cultivation, and self-sustaining ahupua`a.
d. Respect and participate in the resolution of native Hawaiian residual land and water rights issues (kuleana lands, ceded lands, and historic agricultural and gathering rights).
e. Work with appropriate agencies and stakeholders to establish minimum stream flow levels, promote actions to support riparian habitat and the use of available lo`i, and maintain adequate flows for the production of healthy kalo crops.

Recommended Strategies

a. Encourage CWRM to prioritize establishing IFS for diverted streams with potential conflicting uses.

Diversions can and have historically impacted kuleana and appurtenant rights, traditional and customary practices, stream ecology and water quality. In West Maui, diversion data is incomplete and information about existing and potential lo`i kalo and other kuleana needs are not readily available. Community concerns include inadequate stream flow mauka to makai, lack of access to kuleana lands and degraded near-shore water quality. CWRM should focus resources to establish IFS for diverted streams in order to properly assess and balance in and off stream uses.

b. In the absence of established IFS, consider drought conditions as baseline to determine available stream flow for instream and off stream needs.

Healthy streams that support native stream fauna and satisfy water quality and quantity needs for kalo and other cultural uses should be protected. Drought conditions can stress kalo crops that need continuous cool water flow. Where drought flow data is available, drought flow (Q_{90} flow) can guide the assessment of available stream flow for off stream uses, until measureable

IFS are established. This strategy primarily applies to West Maui until contested cases for East Maui and Na Wai Eha are concluded and supports the planning objective of restoring mauka to makai flow.

c. Defer any new surface water diversions to meet projected future demand.

Surface water will remain a contentious resource with potential for significant impact from climate change and drought. To ensure that kuleana and instream needs are protected, no *new* diversions should be supported to meet projected off stream use demand until numerical instream flow standards are established. This strategy is aligned with the planning objective of stream restoration. Maximizing efficiency in distribution and end use of existing diversions can provide additional supply for off stream uses. Leakage reduction in transmission, climate appropriate crop selection and efficient irrigation techniques can continually support the use of untreated surface water for agricultural irrigation. Out of region transfers of surface water has more community backing when end uses support sustainability goals with efficient irrigation, increased renewable energy and local food production.

d. Balance existing diversions with alternative sources for agriculture to mitigate low flow stream conditions

The estimated range in future IFS for East Maui Streams and Na Wai Eha indicate that sufficient surface water could be diverted to meet most projected agricultural demand under normal, or Q_{70} conditions, but not under Q_{90} flow. Under drought conditions, alternative sources are needed to support reliable agricultural supply without compromising in-stream needs. The farming community has expressed the necessity of affordable water to sustain economically viable farming, but likewise the importance of reliable supply for most crops and livestock. Surface water, whether transported from other hydrologic sectors or regionally available, continues to be the most affordable source for farmers to irrigate crops. A diversified supply is needed that combines sufficient reservoir storage to utilize high stream flows in wet season and to capture stormwater and regional rainfall, with non-potable groundwater or alternative sources as contingency. Additional recycled water will become available from the Kahului Wastewater Facility to supplement irrigation needs on the Central isthmus. Stormwater reclamation for agricultural irrigation is assessed for West Maui and discussed under section 12.4. The Agricultural Water Use & Development Plan should address and coordinate with industry stakeholders alternative sources of irrigation water including wastewater reuse, recycled stormwater runoff, and brackish well water.

<u>Surface Water Reliability and Efficiency Issues</u>

Potable and non-potable systems that rely on surface water are highly vulnerable to short and long term drought conditions. Stream flow fluctuates widely by nature as it consists of direct rainfall and runoff of rainfall, water returned from bank storage, and groundwater discharge in the form of base flow. Direct rainfall and runoff from rainfall creates flashy and turbulent conditions, bringing sediment into conveyance and treatment systems. Sediments from high

stream and ditch flows impede treatment processes and impact the water quality. On the other hand, low ditch flows create stagnant water conditions and bacteria growth can cause potable water quality problems. Redundant volume and fluctuations in quantity are main reliability concerns for the MDWS surface water systems.

The infrastructure that conveys and stores surface water often consists of open ditches and large uncovered reservoirs that generate water losses from evaporation and leaks. To improve water efficiency, strategies should target supply side infrastructure as well as the end uses of limited surface water resources.

Despite water quality and quantity challenges, surface water transmitted by gravity to existing reservoirs is by far the least costly source for potable and non-potable uses. Energy intensities would decline significantly if surface water becomes available for rate paying municipal customers as surface water is transported from higher elevation streams to lower elevation population centers largely by gravity. Plantation irrigation systems require substantial maintenance. The EMI and Wailuku Water Company control and maintain their irrigation systems while former plantation systems such as Pioneer Mill in West Maui is broken up among multiple owners. Significant investments are needed to increase the efficiency of these systems and keep ditches and reservoirs functional.

Objectives

a. Increase the efficiency and capacity of the water systems
b. Provide for agricultural needs

General Plan Policies

a. Ensure the efficiency of all water system elements including well and stream intakes, water catchment, transmission lines, reservoirs, and all other system infrastructure
b. Acquire and develop additional sources of potable water
c. Support plans and programs to develop additional sources of water for irrigation purposes.
d. Support the recommendations, policies, and actions contained within the Maui Agricultural Development Plan, July 2009, when consistent with the MIP.
e. Give priority in delivery and use of agricultural water and agricultural land within County agricultural parks to cultivation of food crops for local consumption.

Recommended Strategies

a. Maximize efficiencies in surface water transmission, distribution and storage

Surface water, whether transported from other hydrologic sectors or regionally available, continues to be the most affordable source for farmers to irrigate crops. Proactive maintenance and improvements in system transmission, distribution and storage should be implemented where feasible to reduce water losses. Water audits are recommended for *all* purveyors to identify and target system inefficiencies from source to point of service. Preventive measures and effective maintenance help extend the useful life of transmission,

distribution and storage and ensure timely repairs. Leak detection should be considered to locate and verify system losses and schedule repairs. Covered storage reduces evaporation. Improvements to reduce losses may also extend to kuleana ditches, absent a showing that it is unnecessary to prevent waste, or that it is not practical to do so.[74]

b. Add raw water storage to increase reliable supply

Additional reservoir storage capacity increases the drought period reliable yield of surface water collection, storage and treatment systems. Reservoirs of various capacities were analyzed for the MDWS Kamole, Olinda and Piiholo Water Treatment Facilities (WTF) in the Upcountry Water Advisory Committee Review Draft prepared by Haiku Design and Analysis. A 2015 preliminary engineering report evaluated raw water storage near the Kamole WTF to reduce the effects of low flows in the Wailoa Ditch.[75] This option is a recommended strategy further discussed under the Central ASEA Section 15. Refurbishing and maintaining plantation reservoirs in West Maui for agricultural irrigation is discussed under the Lahaina ASEA Section 19. Storage options for Na Wai Eha are discussed under Wailuku ASEA in Section 14. The optimal capacity of raw water storage is a function of the amount of water and the streamflow characteristics of the streams that feed the reservoirs, the capacities of the stream diversions and transmission from diversion to the reservoir. Additional storage would aid in balancing seasonal use of stream and ground water to reduce conflicting stream uses in dry season and recharge aquifer in wet season (increase surface water use in wet season and develop groundwater to reduce reliance on streams in dry season). Because of the extensive capital cost, raw water storage sizing should be guided by final IFS once established. Financing is another issue in developing large raw water reservoirs. The Hawaii Drinking Water Revolving Funds, a low interest funding option available to public water systems for large capital improvements, can currently not be utilized for reservoirs. However, reservoir construction is eligible to receive Clean Water State Revolving Fund monies, which could be explored further.[76]

c. Increase treatment plan capacity at water treatment plant facilities to accommodate additional treatment in wet season.

Expanding capacity to treat additional ditch flow can provide additional redundancy and economic benefit to take advantage of times when stream and ditch flows are high in wet season. The amount of water available it directly related to IFS. For the Kamole, Piiholo and Olinda WTFs serving the MDWS Upcountry system any off stream uses are guided by IFS. Additional ditch flow through Wailoa ditch also requires an agreement with EMI and

[74] CWRM's Findings of Fact, Conclusions of Law, and Decision and Order in the matter of the ''Iao Ground Water Management Area High-Level Source Water-Use Permit Applications and Petition to Amend Interim Instream Flow Standards of Waihe'e River and Waiehu, 'Iao, & Waikapu Streams Contested Case Hearing, June 10, 2010 (CCH-MAO6-O1).

[75] Austin, Tsutsumi & Associates, Inc. Preliminary Engineering Report for Kamole Water Treatment Plan Raw Water Reservoir(s), May 2015

[76] Northbridge Environmental Management Consultants, Hawaii SRF Management Study for the CWSRF and DWSRF Programs, 2014

consideration of additional untreated water needs at the expanded Kula Ag Park. For the MDWS Iao water treatment facility, the amount of water available from Na Wai Eha for off stream uses is allocated by water use permits. In West Maui, potential expansion of the two existing treatment plants should not be addressed until CWRM establishes IFS to ensure kuleana and instream uses are sufficiently protected.

d. Support plans and programs to develop additional sources of water for irrigation purposes.

Strategies to mitigate drought impact on agriculture were recommended by the Maui Drought Committee. Much of the recommendations are focused on the Upcountry region. Mitigation projects include development of groundwater sources in Kula to supplement the surface water system during drought and extending the current Upper Kula water system or develop a well in Kahikinui. High priority projects that would potentially add source for agricultural irrigation include: implementing the Kula Stormwater Reclamation and Reuse Study; improving surface water sources in Upcountry Maui, which would include adding and improving intakes; and installation of the "dual Agricultural line", a separate agricultural water distribution system to supply untreated water for farmers in the Upper Kula area from the Kahakapao reservoir.[77] . Adding new intakes is not compatible with objectives to curb new diversions and prioritize public trust uses. The "dual Agricultural line" would not generate new source but compete with existing uses of the Upper Kula municipal system. Groundwater development and implementation of stormwater reclamation and reuse would supplement raw water storage and efficiency measures to provide new agricultural irrigation supply. These strategies should be further analyzed in in the statewide Agricultural Water Use and Development Plan (AWUDP) update. The AWUDP should identify and prioritize infrastructure requirements needed to accommodate non-potable water for irrigation. Site selection studies for water storage and supply facilities are needed for Central, Wailuku and Lahaina ASEAs.

e. Prioritize delivery and use of agricultural water within County agricultural parks to cultivation of food crops for local consumption

The Hawaii Department of Agriculture, through its Agricultural Resource Management Division operates ten agricultural parks throughout the state, none of them on Maui. For consistency with General Plan Policies, this strategy specifically addresses the Kula Agricultural Park managed by the County of Maui. The park was created to promote diversification of agriculture in Upcountry Maui on 346 acres. Irrigation to the park is currently supplied by pumping water from the Hamakua Ditch, which is owned by EMI to two storage reservoirs located in the park. The reservoirs are uncovered and have a capacity of approximately 5.4 mgd. Much of the original improvements are still in use. Replacement of reservoir liners was completed in 2011.[78] Various options to provide more reliable supply of irrigation water to the park were

[77] Wilson Okamoto Corporation, County of Maui Drought Mitigation Strategies, October 2004 (Updated June 2012)
[78] Fukunaga and Associates, Inc. Kula Agricultural Park Financial Analysis of the Water System, August 2013 (Revised may 2014)

investigated in a Preliminary Engineering Report prepared by Fukunaga & Associates, Inc. dated November 2006. Because the Kula region is generally dry and ranked at high risk to drought, the drought tolerance of crops, efficient irrigation techniques and back up sources are all of paramount importance.

The County has right to withdraw up to 1.5 mgd from Reservoir 40. The agreement could potentially satisfy current irrigation needs ranging from 0.5 to 0.6 mgd; additional entitlements from Hamakua ditch of 0.351 mgd for Kula 1800 Subdivision and irrigation needs for a 373 acre planned expansion. However, this assumes sufficient ditch flow is available to maintain required volume in Reservoir 40. The park is located at higher elevation than any designated Important Agricultural Lands (IAL). Groundwater as contingency supply is therefore more expensive to develop and pump compared to all other IAL lands historically served by the EMI system. Once IFS are established for the East Maui streams that supply the Hamakua ditch, the county should work with A&B Properties and EMI to ensure priority for Kula Agricultural Park irrigation demand in relation to makai irrigation needs during low flows. Water source agreements with the county should be based on a water audit to ensure reasonable irrigation needs and efficient irrigation techniques. This is consistent with the objective to support food crop cultivation in the park while scrutinizing agricultural irrigation needs, which are not a protected public trust use.

12.4 Alternative Water Source Strategies

Alternative water sources allowed by existing technologies include recycled wastewater, desalination, rainwater catchment and stormwater reuse.

Reclaimed Wastewater

In the WUDP public process, strong community support was voiced for expanding reclaimed/recycled water distribution to off set potable supply for irrigation uses, especially in dry areas.

Issues and Opportunities

Increased of reclaimed wastewater is a feasible method of supplying non-potable needs such as landscape irrigation. The State Water Code HAR174C-31 as amended in 2016 adds as an objective of the Hawai'i Water Plan, “The utilization of reclaimed water for uses other than drinking and for potable water needs in one hundred percent of state and county facilities by December 31, 2045.” However, the Food Safety Modernization Act restricts uses or reclaimed water on crops. Application of recycled water over potable aquifers also raise concerns in terms of contaminants that are not removed by sewage treatment technologies and that could potentially pose a risk to drinking water quality. Another challenge is the general public’s acceptance of reuse of water.

Like sewer rates, reclaimed water rates need to reflect more of the actual cost of delivering this resource to users. Significant expansion of reclaimed water would require a considerable increase in rates to debt service and pumping costs. This cost may actually be more than what is would cost to deliver potable water for non-potable uses, but does not factor in the external benefits associated with water conservation and reducing the island's reliance on injection wells. Water recycling and water reuse projects that replace potable sources with non-potable sources are eligible for funding through the Drinking Water State Revolving Fund (DWSRF), including greywater, condensate, and wastewater effluent reuse systems, as well as extra treatment costs and distribution pipes associated with water reuse.[79] DWSRF funds may be under-utilized in county initiated expansion of recycled water use.

Maui County Reclaimed Water Program

The County of Maui Department of Environmental Management administers the reclaimed wastewater program. Wastewater disposal via injection wells continue to be a concern. Sewer user fees are the primary source of funds for the production and delivery of reclaimed water. While this strategy was effective in the early stages of the program begun in 1990, more recently the County has delayed the implementation of planned reclaimed water projects due to higher-priority sewer improvement projects, which has slowed the development of infrastructure necessary to increase water reuse from County facilities.

The 2013 Update of the Hawai'i Water Reuse Survey and Report identifies short-term potential water reuse opportunities for County and private facilities. Information has been updated for County facilities resulting in the following projections. Proposed use is for generally for landscape and golf course irrigation. Details are provided in the Sector Reports.

Table 12-9 Short Term Projected Recycled Water Use

WWRF	WWRF Design Capacity (MGD)	Projected Recycled Water Use (Ave. MGD)	% of Design Capacity Used
Wailuku-Kahului	7.9	2.25	28.5%
Kihei	8	2.2	27.5%
Lahaina	9	1.84	20.4%
County WWRF Total	**24.9**	**6.29**	
Existing Private	1.23	0.45	36.2%
Proposed Private*	--	1.7	--
Private Total	**--**	**2.15**	**--**
Total		**8.44**	

Update of the Hawai'i Water Reuse Survey and Report, July 2013.
http://files.Hawai'i.gov/dlnr/cwrm/planning/hwrsr2013.pdf. County of Maui Environmental Management Dept,, Wastewater Reclamation Division, September 28, 2015.

[79] 2010 Clean Water and Drinking Water State Revolving Fund 20% Green Project Reserve: Guidance for Determining Project Eligibility, Part B – DWSRF GPR SPECIFIC GUIDANCE; Northbridge Environmental Management Consultants, Hawaii SRF Management Study for the CWSRF and DWSRF Programs, 2014.

* Some projects have not reported recycled water use projections and it is uncertain whether some projects would be served by County or private WWRFs.

Objectives

a. Increase the efficiency and capacity of the water systems in striving to meet the needs and balance the island's water needs

General Plan Policies

a. Maximize the efficient use of reclaimed wastewater to serve non-potable needs
b. Promote the reclamation of gray water, and enable the use of recycled, gray, and brackish water for activities that do not require potable water.
c. Explore and promote alternative water-source-development methods.

Recommended Strategies

a. Expand requirement for new development to connect to recycled water infrastructure if practical.

   Maui County Code, Chapter 20.30 requires commercial properties within 100 feet of the county's reclaimed water system to connect and use R-1 water for landscape irrigation. Expanding distribution and use of recycled water can be achieved through mandatory or incentivized hook up for particular properties and uses. A code amendment can increase the spatial requirement for connection, or allow a determination by the County Department of Environmental Management (MDEM) when reclaimed water can be feasibly provided in lieu of potable water for specific projects and uses.

b. Promote closer collaboration between MDWS and MDEM to master plan and utilize DWSRF funding to maximize recycled water use.

Demand and conservation of potable water determines wastewater treatment capacities and available recycled wastewater. Wastewater discharge through injection wells directly impacts groundwater recharge and quality. The nexus between recycling wastewater and reducing demand for drinking water treatment should be addressed collaboratively in long term resource planning. MDWS services sewer billing but has no further role in management of recycled wastewater. Collaboration in water management and creative funding with support from the State Department of Health Safe Drinking Water Branch could optimize distribution and end uses for recycled wastewater to off set potable water use.

c. Explore expansion of "scalping plants" (small-scale membrane filter systems that put effluent closer to reuse locations) in designated growth areas.

Increasing costs associated with operating and maintaining large distribution systems make small-scale treatment close to wastewater generation more feasible. Decentralized wastewater treatment in dry growth areas would avoid costly transmission and provides an alternative source of irrigation supply on site. Scalping plants can withdraw wastewater and treat it to a

specific limit depending on the end use. The county should support small scale on site treatment where feasible to maximize recycled water use for irrigation in new development.

Rainwater Catchment Systems

Issues and Opportunities

Rainwater catchment is not as reliable as conventional water resources because it is extremely sensitive to the climate. Catchment for agricultural irrigation should be further explored where consistent rainfall makes the systems feasible.

Objectives

a. Increase the efficiency and capacity of the water systems in striving to meet the needs and balance the island's water needs

General Plan Policies

a. Ensure the efficiency of all water system elements including well and stream intakes, water catchment, transmission lines, reservoirs and all other system infrastructure
b. Encourage increased education about and use of private catchment systems where practicable for non-potable uses

Recommended Strategies

a. Inform and educate the residential and commercial community of easy, affordable rainfall catchment for recharge and garden use

Rainfall catchment stored in a tank or underground storage system can be used for landscape irrigation to offset potable supply. Water quality can be an issue and there is currently no state or county oversight regulating household catchment systems. State Department of Health and county agencies should further community outreach targeting households in areas not served by any public water system and promote catchment as a water conservation strategy for new commercial landscaping with potential incentives.

b. Provide incentives for residential rainwater catchment systems

A rainwater harvesting pilot program for residential irrigation uses is considered in the MDWS conservation program portfolio.

Stormwater Reuse

Issues and Opportunities

Capture and reuse of stormwater runoff is an under-utilized water resource that provides an opportunity to reduce reliance on groundwater and surface water for landscape irrigation, especially when incorporated into the design of development projects in order to minimize infrastructure costs. The *Hawai'i Stormwater Reclamation Appraisal Report, 2005, and Study Element 3: An Appraisal of Stormwater Reclamation and Reuse Opportunities in Hawai'i*,

September 2008, screened and identified four projects on Maui within the final ranking, which might provide opportunities to augment agricultural irrigation water that is diverted currently from Maui streams, in addition to providing other benefits:[80]

- Waiale Road Stormwater Drainage: This opportunity uses an existing stormwater drainage channel and detention pond located along Waiale Road to capture and convey stormwater into the Waihe'e and Spreckels Irrigation Ditch Systems for agricultural irrigation to the south and east. The pressure to reduce stream diversions associated with Spreckels and Waihe'e Ditches puts increased pressure on agricultural water demands for Central Maui. The decline in agriculture in Central Maui has resulted in a significant decline in return irrigation recharge of the aquifers.
- Kahului Flood Control Channels: This opportunity uses an existing stormwater drainage channel in urban Kahului Town to collect stormwater for agricultural irrigation to the south of Kahului Town.
- Kahoma Stream Flood Control: This opportunity uses an existing stormwater drainage channel (Kahoma Stream) to collect and convey stormwater for agricultural use to the north
- Lahaina Flood Control: This opportunity uses an existing stormwater drainage channel and detention pond located adjacent to the Lahaina Wastewater Reclamation Facility (WWRF) to collect stormwater for conveyance to agricultural areas to the north, south, and east.

Recommended Strategies

a. Explore and promote opportunities for large volume stormwater runoff for agricultural irrigation.

Incentives for landowners and agricultural users are needed that mitigate pollutant loads and take advantage of filtered runoff for non-potable end uses. Creative funding for large volume reuse projects is key. Future potential grant opportunities may become available through state legislative initiatives such as the CWRM Water Security grant funds. Pending legislation would require the CWRM to include plans for storm water management, reuse, reclamation and remediation in the Water Resources Protection Plan.

Desalination

Issues and Opportunities

Desalination is more costly than conventional water resources due to treatment and monitoring requirements, although costs have been decreasing. The energy intensive

[80] Hawai'i Stormwater Reclamation Appraisal Report, 2005, and Study Element 3: An Appraisal of Stormwater Reclamation and Reuse Opportunities in Hawai'i, September 2008. http://files.Hawai'i.gov/dlnr/cwrm/planning/hsrar_element3.pdf

technology currently available would add freshwater supplies but not provide other environmental co-benefits. Supplying 10% of Maui's current municipal demand with brackish desalinated water would require an estimated 14% of MDWS current energy demand. The energy demand for the same amount of seawater desalination would be about 45% of current MDWS energy demand. [81]

Brackish groundwater is likely to the preferred resource for desalination to meet potable water quality because monitoring requirements are not as stringent as they are for surface water sources. In addition, desalination of brackish water is generally more cost-effective and environmentally-friendly than use of sea water. Effects on groundwater resources and chlorides due to anticipated reduced irrigation association with the cessation of sugarcane production are issues, along with impacts on source water quality, and wastewater disposal injection wells. However, since brackish groundwater contributes toward the sustainable yield of the aquifer, desalination of sea water can be advantageous because it is not a limited resource.[82] Overall, desalination may have potential within the 20-year planning horizon but does not warrant a recommended strategy aside from continued monitoring of progress in technology and energy use.

12.5 Land Use Controls

The Maui Island Plan Directed Growth Plan and designation of Urban and Rural Growth Boundaries ensures an adequate supply of land is available for future growth, while limiting sprawl and focusing infrastructure investment to areas within the growth boundaries. Development through planned urban infill and redevelopment also increases population density and prevents expansion of non-agricultural irrigated acreage. Maui County has zoning jurisdiction of land designated for Urban within the State Land Use District. Zoning provides density controls through housing unit and acreage controls. The WUDP complements the Directed Growth Plan by allocating conventional and alternative resources to planned growth, coupled with aggressive conservation to reduce per capita demand.

Maui County has approximately 244,000 acres of land designated for agricultural use within the State Land Use District. [83] The state and county have enacted zoning laws to protect agricultural resources and promote agricultural activities. The Agricultural Zoning District provides for distribution of minimum lot sizes to decrease the fragmentation of agricultural lands. This approach also ensures green and scenic open space. Transfer and purchase of development rights and conservation subdivision design are other tools that can protect important agricultural lands and direct development to areas suitable for development. [84]However, this approach does not consider the associated irrigation needs or location of water resources. Agricultural water use represents about 63 percent of groundwater pumpage and about 90 percent of surface water resources. Concentrating farm land as agricultural parks,

[81] E.A. Grubert and M.E. Webber, Energy for water and water for energy on Maui Island, Hawaii, April 2015
[82] WRPP, 2008
[83] State of Hawaii DBEDT (2008). The State of Hawaii Data Book
[84] Maui Island Plan, 2012, page 7-5

considering irrigation needs, optimally based on natural rainfall, could capitalize on collective non-potable and alternative water supply and infrastructure. Agricultural parks as both a resource and land use control could be further explored to protect and sustain the island's commercial agriculture while alleviating future demand on potable water supply and infrastructure.

13 SUMMARY OF RECOMMENDATIONS

Recommendations described in Table 13-1 summarize the strategies discussed throughout Chapter 12 and how they relate to planning objectives. The planning objectives were developed through an extensive public process that incorporates input from advisory groups that addressed the Central and Upcountry MDWS systems only prior to 2010, stakeholder meetings, open public meetings and workshops held throughout 2015 and 2016. Values and principles derived from this process provide the overall guidance to define strategies. Specific recommendations for each aquifer sector area are presented in Section III. However, general recommendations and policies summarized below are applicable island-wide. Recommendations include policies and actions that on a county level should provide the foundation and guidance for MDWS capital improvement program and budget, public/private partnerships, studies and land use decisions. On a state level, recommendations should provide guidance to the CWRM in their decisions regarding pumping permits, stream withdrawals, water reservations and other matters.

13.1 Planning Objective Conflicts and Recommended Tradeoffs

When MDWS reignited the WUDP public process at the end of 2015, the approach was to create an actionable plan with no further delays while striving to address long-standing conflicts and concerns related to water resource management and use on Maui. The WUDP is intended to allocate water to existing and planned land use. The following challenges related to water systems were identified in the MIP and echoed in the WUDP public process:

- Native Hawaiian water rights must be incorporated into water planning.
- Lack of scientifically based interim flow standards which relate to water rights and public trust purposes and planning for surface-water resources.
- Future agricultural water use is uncertain.
- Comprehensive water resources planning and system control, while the County controls a relatively small percentage of the water on the island.
- MDWS budget constraints in the face of rising costs and infrastructure repair and replacement needs.
- Energy production and efficiency is a substantial component of MDWS costs.
- Private water systems and wells can undermine public systems or have the potential for contamination of water resources.

Objectives are generally complementary but in some cases conflicting. A predominant example is transport of surface and ground water from resource abundant wet areas to dry growth areas versus reliance on regional resources. In each regional aquifer sector plan, strategies strive to provide a balance among conflicting objectives under the guidance of overall values and principles.

13.2 Implementation and Funding

Implementation Process

Formulation of the WUDP has included relevant data, technical reports and resources derived from the MIP process and coordination with the Maui County Planning Department's Long Range Planning Division, which is responsible for the preparation, adoption and implementation of the MIP. In turn, projections, policies and strategies in the WUDP can inform the Community Plan updates and future MIP amendments. The WUDP and the MIP make up a framework to ensure that land use and infrastructure planning are integrated and provide guidance for resource use and infrastructure development. In consistency with the Maui County Code Title 14, the plan shall serve as the primary guide to the council, the department, and all other agencies of the county in approving or recommending to other agencies the use or commitment of the water resources in the county; and in using public funds to develop water resources to meet existing or projected future demands on the MDWS system.

Upon County Council adoption and CWRM approval of the WUDP, implementing actions to effectuate the intent of the policies and strategies should be developed over the twenty-year planning period. Agencies and organizations tasked with scoping and refining strategies into projects are identified, with the expectation that lead roles and additional parties be further determined over the planning period. Estimated timeframes for implementation are indicated allowing for flexibility to re-scope, prioritize and adjust to available funding. Actual implementation will depend on level of capital funding, conclusion of contested cases and other CWRM actions, detailed design and planning, and other factors. Implementation timeframe is broken down into near term (next one to three years) and long term (three to twenty years).

Funding

Funding to address island wide and region specific strategies is primarily shared between state and county agencies, with the greatest burden on MDWS. Funding sources for county infrastructure is summarized in Chapter 10 of the MIP Implementation Program.[85] Sources of revenues for MDWS are monthly water service fees: water system development (impact) fees, bond financing and State Revolving Fund loans.

Water service fees are charged to all customers, which make the distribution of such costs equitable throughout the community. Monthly water service charges are the primary revenue source for operations, maintenance and upgrades to existing systems.

Costs associated with facility expansion, including new source should be borne primarily by new development to ensure that costs are distributed equitably to uses benefitting from the improvements. The water system development fee includes source, storage and transmission

[85] Ordinance No. 4126, Bill No. 29 (2014) A Bill for An Ordinance Adopting the Maui Island Plan Implementation Program, May 29, 2014. Page 10-6

fees for capital Investments and are charged by meter size. The source portion of the fee should provide for adequate source to meet peak use for the water service.

Life cycle costs for the twenty-year planning period were assessed for most region specific conventional and alternative resources in Part III Regional Sectors. Life cycle costs include capital, operational and maintenance costs and include inflationary effects. Costs are estimated for each 1000 gallons of water provided or offset for comparative planning purposes. Major capital improvements for conventional resource strategies under the jurisdiction of MDWS were roughly assessed in the MIP to meet projected demand to year 2030. The overall description and estimated costs for the four MDWS systems on Maui have not changed significantly:

1. Central Maui Water System: Source development depending on the combination of new sources pursued: $100 million
2. West Maui Water System: Source development depending on the combination of new sources pursued. Costs do not include the development of raw water storage: $100 million
3. Upcountry Water System: Source development costs are based on satisfying a significant portion of the upcountry water meter list. This demand is far in excess of demand projected in the Maui Island Plan: $100 million
4. East Maui System: Various combinations of source, storage and transmission improvements: $10 million

Rate studies are continuously undertaken to ensure that water rate structures and amounts provide sufficient revenue for system services. Future rate studies will incorporate the adopted WUDP to secure revenues for priority needs. However, it's not feasible to establish water rates and fees to reflect all strategies over the twenty year planning period, due to the many uncertainties and the anticipated need for adjustments. Instead, as the WUDP strategies are refined into county CIP projects and programs, water rate and fees should be evaluated and aligned to match priority needs. When major investments are made infrequently and the true cost of services are underfunded, catching up can be cumbersome and negatively perceived. Based on a historical lag in rate and water system development fee increases to reflect actual needs, water rate and fee increases by more than 50% between 2015 and 2030 would be needed to adequately fund maintenance of the current infrastructure and capital improvement projects to meet projected demand.

Some strategies rely on funding by private water purveyors, non-government organizations and public-private partnerships that will require detailed planning and alternative funding solutions. In consistency with the MIP, identification of strategies in the WUDP does not legally bind the agencies and organizations to implement the project and activities, rather the plan provides a guidance for land use and infrastructure, including the county CIP program, over the planning period.

Table 13-1 Summary of Recommended Strategies

	STRATEGY	PLANNING OBJECTIVES	ESTIMATED COST	IMPLEMENTATION 1: Short-term 1 – 5 years 2: Long-term 5 – 20 years	
				AGENCY*	TIME-FRAME**
	RESOURCE MANAGEMENT				
	Watershed Management				
1.	Continue Maui County financial support for watershed management partnerships' fencing and weed eradication efforts.	Maintain sustainable resources Protect water resources Protect and restore streams	$2 million per year/$8 per watershed acre (249,362 ac)	MDWS Maui County	1
2.	Promote increased distribution of funding for watershed protection and active reforestation to reflect multiple values and ecosystem services.	Maintain sustainable resources Protect water resources Protect and restore streams	N/A	Private water purveyors Land owners DLNR	1
3.	Expand watershed protection to incorporate the ahupua`a as a whole and utilize ahupua`a resource management practices.	Maintain sustainable resources Protect water resources Protect and restore streams Protect cultural resources	N/A	Public-private partnerships Aha Moku DLNR Maui County	1
4.	Support stream restoration and increased use of *kalo* lands.	Maintain sustainable resources Protect water resources Protect and restore streams Protect cultural resources	N/A Lo'i restoration projects can start from $50,000. Site specific	CWRM Aha Moku Community grassroots Maui County	1
5.	Enable and assist in providing for Native Hawaiian water rights and cultural and traditional uses through active consultation and participation.	Protect and restore streams Protect cultural resources	N/A	CWRM Maui County Aha Moku	1
	Water Quality Management				
6.	Implement well siting criteria to avoid contaminated groundwater supplies and unnecessary risks to public health.	Maximize water quality	Potentially increased pumping costs for higher elevation wells, site specific	MDWS Public Water Systems	1
7.	Adopt wellhead protection measures for potable wells.	Protect water resources Maximize water quality	DOH grant funded public outreach and research	MDWS Maui County	1

			completed		
8.	Educate the farming community in sustainable farming practices to reduce impact from agricultural practices on water resources.	Protect water resources Maximize water quality	Outreach within multiple agency budgets. From $5,000 annually	DOA DOH MDWS HRWA SWCD	1
9.	Update assessment of potential contaminating activities around drinking water supply and support increased monitoring of potable wells as needed.	Maximize water quality	$10,000 - $20,000, five year updates	Maui County MDWS	1
	Conservation – Demand Side				
10.	Retrofits/direct installation and sub-metering programs, distribution of water-efficient fixtures and retrofits for existing users and facilities	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply	MDWS ongoing and pilot programs $108,000 year 1 - 3	MDWS	1
11.	Smart meters retrofits	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply	Depends on existing meters and model, conversion from $150/meter	Private water purveyors MDWS	2
12.	Landscaping and irrigation system incentives, targeting dry areas.	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply Manage water equitably	Being assessed	Maui County Parks Dept MDWS	2
13.	Public information and education: sustainability working group; technology/innovation transfer programs; recognition program; public events; participation in recognized federal and industry programs (WaterSense); advertising	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply	MDWS ongoing programs $50,000 annually	MDWS HRWA Public Water Systems	1
14.	Landscaping guidelines, audit and retrofit, landscape ordinance.	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply	Being assessed	MDWS	1
15.	Market/customer surveys followed by rebates and incentives: high efficiency fixtures, washing machines, toilets and urinals; hotel awards program	Maintain sustainable resources Maximize efficiency of water use	Being assessed	MDWS	1

		Minimize cost of water supply			
16.	Revise county code to require high efficiency fixtures in all new construction. Develop a comprehensive water conservation ordinance to include xeriscaping regulations.	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply Manage water equitably	N/A	Maui County	2
17.	Aggressive tiered rate structure based on audit and rate study.	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply Manage water equitably	N/A	Maui County MDWS	1
18.	Agricultural programs: Irrigation efficiency audits, technical assistance and rebates. Ag technical working groups.	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply Provide for agricultural needs	Outreach within multiple agency budgets. From $10,000 annually	DOA DOH MDWS HRWA SWCD	1
19.	Greywater incentives	Maintain sustainable resources Maximize efficiency of water use	MDWS 2 year pilot program $80,000	Maui County MDWS	2
20.	Rainwater catchment for irrigation – educational.	Maintain sustainable resources Maximize efficiency of water use	N/A	DOH Private water purveyors Maui County	2
21.	Revise County Code and/or incentives: water conserving design and landscaping in new development (xeriscaping targets dry areas), water efficient irrigation systems	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply Manage water equitably	N/A	Maui County	2
22.	Revise County Code and/or incentives: Water-efficient building design integrating alternative sources (grey water, catchment).	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply Manage water equitably	N/A	Maui County	2
23.	Restrict outdoor water waste (no runoff, water wasting, hose nozzles).	Maintain sustainable resources Maximize efficiency of water use	N/A	Maui County MDWS drought rules	1

		Minimize cost of water supply			
24.	Targeted conservation programs in dry areas and drought conditions.	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply Manage water equitably	N/A	Maui County MDWS water shortage rules	1
25.	"Lead by Example" conservation and efficiency projects.	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply Manage water equitably	N/A	MDWS Maui County Parks Dept	2
	Conservation – Supply Side				
26.	Perform annual comprehensive water audits.	Maximize efficiency of water use Minimize cost of water supply	Staff costs only, free software and training	MDWS Public Water Systems	1
27.	Fund and implement a continuous leak detection program.	Maximize efficiency of water use Minimize cost of water supply	From $100,000 annually	MDWS Large Public Water Systems	1
28.	Maintain and operate the water system to minimize the sources of water loss.	Maximize efficiency of water use Minimize cost of water supply	N/A	MDSWS Private water purveyors	1
	Conservation – Agricultural Uses				
29.	Research, support and use of less water consumptive crops and climate adapted crops.	Maintain sustainable resources Maximize efficiency of water use Manage water equitably	N/A	DOA	2
30.	Improve irrigation management and efficiency.	Maintain sustainable resources Maximize efficiency of water use Manage water equitably	N/A	UH CTAHR USDA SWCD Hawai`i Farm Bureau Hawai`i Organic Farmers Association	2
31.	Maintain the integrity of plantation irrigation systems including reservoirs.	Maximize efficiency of water use Provide for agricultural needs	N/A	Public-private partnerships (EMI, MLP, WWC, West Maui Land)	2

				Maui County DLNR DOA	
32.	Augment agricultural water supplies with alternative resources.	Maintain sustainable resources Manage water equitably Provide for agricultural needs		Maui Dept of Public Works DLNR	2
	Conservation – Energy				
33.	Pursue comprehensive energy management.	Minimize adverse environmental impacts Minimize cost of water supply	N/A	MDSWS Public Water Systems Maui County Energy Management Program	1
34.	Increase energy efficiency and improve load management.	Minimize adverse environmental impacts Minimize cost of water supply	Being assessed	MDSWS Public Water Systems Maui County Energy Management Program	2
35.	Increase alternative energy generation and use.	Minimize adverse environmental impacts	N/A	MDSWS Public Water Systems Maui County Energy Management Program	2
	Conventional Water Source				
36.	Support collaborative hydrogeological studies to inform impact from climate change and future well development on groundwater health.	Maintain sustainable resources Protect water resources	From $600,000, joint funding. Site and resource specific	CWRM MDWS Public Water Systems USGS	1
37.	Develop groundwater within sustainable yield to provide sufficient supply for growth, maintaining a buffer to account for potential future drought impact and prospective adjustments in aquifers lacking hydrologic studies.	Maintain sustainable resources Maximize reliability of water service	Site specific, see regional sectors	CWRM MDWS Private water purveyors	1
38.	Promote the highest quality water for the highest end use	Manage water equitably	N/A	CWRM MDWS Private water purveyors	1
39.	Protect and prioritize public trust uses in allocating groundwater in regions of limited resources and conflicting needs.	Manage water equitably Provide for Department of Hawaiian Homelands needs	N/A	CWRM MDWS DHHL	1

40.	Increase monitoring of groundwater sources to assess water and chloride levels in potable and non-potable wells throughout developed aquifers.	Maintain sustainable resources	From $50,000 annually monitoring, site specific	CWRM USGS	2
41.	Promote well siting and distribution strategies for all public water systems to ensure optimal spacing and withdrawals for aquifer health and equitable use.	Maintain sustainable resources Manage water equitably	N/A	CWRM Maui County MDWS Private water purveyors	2
42.	Formalize demand response plans for water purveyors that address water shortage and aquifer changes.	Maintain sustainable resources Maximize reliability of water service	None	CWRM MDWS Private water purveyors	2
43.	Develop a water availability rule to provide certainty in land use planning and ensure that reliable source and infrastructure capacity is provided within reasonable time for planned growth.	Maximize reliability of water service Maintain consistency with General and Community Plans	None	Maui County MDWS	2
44.	Increase system flexibility so that regional sources can be moved to support areas of need, both within the municipal systems and between regional public water systems.	Maximize reliability of water service Maximize efficiency of water use	See regional sectors	MDWS	2
45.	Ensure that public/private groundwater development agreements reflect the public trust needs and are in keeping with the water allocation priorities of the MIP.	Maximize reliability of water service Manage water equitably Maintain consistency with General and Community Plans	N/A	Maui County MDWS Public Water Systems	2
46.	Develop groundwater to maximize reliability of potable supply and as contingency in areas currently dependent on surface water.	Maximize reliability of water service	See regional sectors	MDWS Public Water Systems	2
47.	Diversify supply for agricultural use to increase reliability	Provide for agricultural needs Maximize reliability of water service	See regional sectors	DOA Maui County Private water purveyors	2
48.	Encourage CWRM to prioritize establishing IFS for diverted streams with potential conflicting uses.	Protect and restore streams Minimize adverse environmental impacts	N/A	CWRM	2

		Manage water equitably Protect cultural resources			
49.	In the absence of established IFS, consider drought conditions as baseline to determine available stream flow for instream and off stream needs.	Protect and restore streams Protect cultural resources	N/A	CWRM MDWS Private water purveyors	1
50.	Defer any new surface water diversions to meet new projected demand.	Protect and restore streams Protect cultural resources	N/A	CWRM Maui County	1
51.	Balance existing diversions with alternative sources for agriculture to mitigate low flow stream conditions.	Provide for agricultural needs Maximize reliability of water service	N/A	DOA Maui County Private water purveyors	2
52.	Maximize efficiencies in surface water transmission, distribution and storage.	Maximize efficiency of water use	N/A	Private water purveyors (EMI, MLP, WWC, West Maui Land)	2
53.	Add raw water storage to increase reliable supply once instream flow standards are established.	Maximize reliability of water service	See regional sectors	MDWS	2
54.	Increase treatment plan capacity at water treatment plant facilities to accommodate additional treatment in wet season.	Maximize reliability of water service Minimize cost of water supply	See regional sectors	MDWS	2
55.	Support plans and programs to develop additional sources of water for irrigation purposes.	Provide for agricultural needs Maximize reliability of water service	See regional sectors	DOA Maui County Private water purveyors	1
56.	Prioritize delivery and use of agricultural water within County agricultural parks to cultivation of food crops for local consumption.	Provide for agricultural needs Maximize reliability of water service	N/A	Maui County EMI MDWS	2
	Alternative Water Source				
57.	Expand requirement for new development to connect to recycled water infrastructure if practical.	Protect water resources Maintain consistency with General and Community Plans	N/A	Maui County	2
58.	Promote closer collaboration between MDWS and MDEM to master plan and utilize DWSRF funding to maximize recycled water use.	Maximize efficiency of water use Maintain consistency with General and Community Plans	N/A	Maui County MDEM MDWS	2

59.	Explore expansion of "scalping plants" (small-scale membrane filter systems that put effluent closer to reuse locations) in designated growth areas.	Maximize efficiency of water use Maintain consistency with General and Community Plans	N/A	MDEM	2
60.	Inform and educate the residential and commercial community of easy, affordable rainfall catchment for recharge and garden use	Protect water resources Maintain consistency with General and Community Plans	Outreach within multiple agency budgets. From $5,000 annually	DOH MDWS	2
61.	Provide incentives for residential rainwater catchment systems.	Protect water resources Maintain consistency with General and Community Plans	MDWS pilot program $45,000 over 2 years	MDWS	2
62.	Explore and promote opportunities for large volume stormwater runoff for agricultural irrigation.		N/A	DLNR DOA MDPW	2

*Abbreviations:

CWRM	Commission on Water Resource Management
DHHL	State of Hawai'i Department of Hawaiian Home Lands
DLNR	State of Hawai'i Department of Land and Natural Resources
DOA	State of Hawai'i Department of Agriculture
DOH	State of Hawai'i Department of Health
EMI	East Maui Irrigation Company
HRWA	Hawai'I Rural Water Association
Maui County	Maui County Administration and Maui County Council
MDEM	Maui County Department of Environmental Management
MDPW	Maui County Department of Public Works
MDWS	Maui County Department of Water Supply
MLP	Maui Land and Pineapple Company
SWCD	Soil and Water Conservation District
UH CTAHR	University of Hawaii College of Tropical Agriculture and Human Resources
USDA	U.S. Department of Agriculture
USGS	U.S. Department of the Interior, U.S. Geological Survey
WWC	Wailuku Water Company

**Implementation Timeframe
1: Short-term 1 – 5 years
2: Long-term 5 – 20 years